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Guideline Series: Guidance Document for Residential Wood Combustion Emission Control Measures

Radian Corp., Austin, TX

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16. ABSTRACT

This publication was prepared to provide guidance to State and local air pollution control agencies with regard to emission control measures for residential wood combustion (RWC). The guidance is specifically directed to agencies that are required by the U.S. EPA to demonstrate through the State implementation planning process that the national ambient air quality standard for PM-10 will be attained. There are four categories of RWC emission control measures: public awareness, combustion efficiency, restriction or reduction in the number of RWC devices, episodic curtailment. A hierarchy of effectiveness and reliability of emission control measures is presented. Methods for developing estimates of RWC emissions are presented in order to apply a quantitative estimate of effectiveness of control measures.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
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SECTION 1
INTRODUCTION

1.1 SCOPE OF THIS DOCUMENT

The purpose of this document is to assist state and local officials in developing plans for controlling emissions from residential wood combustion (RWC) devices. Specifically, this document is designed to provide guidance to officials in areas that are required by the U.S. Environmental Protection Agency (EPA) to demonstrate through the State Implementation Planning (SIP) process that they will attain the national ambient air quality standard (NAAQS) for particulate matter of 10 micrometers in aerodynamic diameter or less (PM-10).

None of the measures discussed in this document, except the New Source Performance Standards, are "national measures." Some of these measures could be adopted by state or local areas that exceed a federal or state particulate matter standard or areas where RWC emissions are a community concern.

This introduction includes a background section (1.2) that describes the extent of the RWC emission problem, the causes of RWC emissions, and the means of controlling these emissions. This section also provides a brief overview of the two regulatory mechanisms for addressing the RWC emissions problem on a national basis: EPA's new source performance standard (NSPS) for wood heaters and the PM-10 NAAQS. Section 1.3 briefly discusses the health effects issues associated with RWC. Section 1.4 presents a hierarchy of effectiveness and reliability of emission control measures.

Sections 2 through 5 describe four categories of RWC emission control measures. The first of these four control measures, public awareness (PA), is addressed in Section 2. A basic assumption behind PA is that RWC emissions can be reduced if the wood-burning public knows why RWC emissions are harmful, is aware of the full range of benefits from reducing RWC emissions, and knows how to reduce these emissions. (Note: This document does not focus on the emission control technology required by the NSPS.)

Section 3 addresses control measures that have as their objective an improvement in combustion efficiency. These measures include: (1) banning specific types of solid fuel-burning residential heating (RWC) devices, (2) ensuring proper installation of RWC devices, (3) upgrading fuel quality, and (4) reducing demand for fuel use through weatherization of residences, conservation, and other techniques.

Section 4 discusses measures that have as their objective, the reduction in the use of RWC devices impacting the airshed. This occurs through conversion to alternative fuels and by requirements to remove or limit wood heaters.

Section 5 addresses episodic curtailment -- the temporary cessation of wood burning to avoid periods of high ambient concentrations of woodsmoke.

Each of these sections includes an estimate of the effectiveness of each type of control measure. These estimates are provided in order that state and local communities can use them to develop their plans to reduce RWC emissions to a targeted level and for EPA regional staff to use in awarding emission credits when evaluating PM-10 SIPs. These estimates are based primarily upon the informed judgment of the authors of this report and especially the consensus of the Technical Review Committee, which was composed of knowledgeable authorities in the field.

Many of these estimates of effectiveness are intended to be examples of the credits or range of credits that would be granted for a particular control measure. A state or local agency may be able to demonstrate that a different credit would be justified in a particular situation. This could be accomplished through discussion with the EPA Region prior to SIP submittal.

With a few exceptions, each of the individual measures discussed in this document are currently being used in several states and local areas. This document is based, in large measure, upon scores of telephone interviews with officials who are operating these RWC emission control programs. Although the experiences of these local programs are referred to extensively in this document, this document is not intended to be a survey of all state and local RWC emission control programs. The list of those interviewed was drawn from recommendations from EPA staff in EPA Regions where RWC emissions contribute significantly to PM-10 nonattainment and where RWC control programs are most developed. These interviews were supplemented by literature describing the programs. The names of those interviewed and other literature used in this document are cited in the references in Section 6.

In order to apply a quantitative estimate of effectiveness (or credit), it is important to develop a good estimate of RWC emissions. Methods for developing RWC emission estimates are presented in Appendix A along with additional references for those interested in conducting community RWC surveys to develop an RWC data base.

Appendix B lists the Technical Review Committee members and others who prepared this report. Appendix C contains copies of ordinances and regulations that provide the legal authority and description of various programs discussed in this document. Appendix D is a four-page "Fact Sheet" on the "Potential Health Effects Associated with Woodsmoke." This is a useful summary prepared by EPA and suitable for inclusion in state and local PA programs. Appendix E shows, by way of a hypothetical example how these emission reduction credits can be applied in an RWC emission control program consisting of separate program elements. Finally, Appendix F is a summary description of all control measures and associated credits.

A final note on terminology and the scope of this document: although the topic is residential wood combustion, often many of the programs can be aimed broadly at all solid fuel combustion (which would include coal-fired heaters) in residences as well as other nonresidential settings (stores, shops, offices, schools, etc). On the other hand, some programs pertain only to certain types of solid fuel combustion devices while exempting others. To avoid confusion, the words "RWC devices" will be used to address all solid fuel emission sources generically. Fireplaces, wood stoves, wood heaters, pellet burners, wood-fired central heaters and furnaces, and coal-fired appliances are all specific types of RWC devices. Similarly the term "RWC emissions" will be used to refer to PM-10 emissions from RWC devices.

The word "program" refers to a community's collective efforts to control RWC emissions through several "control measures" or "program elements."

1.2 BACKGROUND

This section briefly discusses the extent of the RWC emissions problem, the cause of the problem, the means of reducing these emissions, and EPA's regulatory strategies for promoting these controls.

1.2.1 RWC Emissions: Extent of the Problem, Causes, and Control Techniques

1.2.1.1 Extent of the Problem --

Estimates of the number of RWC units in the United States vary. A 1983 survey conducted for the Consumer Product Safety Commission indicated that there were 27 million RWC devices in use (43). More than half of these were either the traditional masonry fireplaces or the metal zero clearance or freestanding fireplaces. The remainder were enclosed fireplace inserts, woodstoves, or furnaces. Counting coal-fired appliances (which usually make up at least four percent of solid fuel heater sales) and adding the roughly one million new RWC units sold each year, it is reasonable to estimate that by 1989 there were approximately 30 million RWC units (49).

RWC devices are one of the largest man-made sources of PM-10 and carbon monoxide (CO) in the country. In gathering data to support the development of national emission standards for enclosed wood heaters (i.e., primarily wood stoves and fireplace inserts), EPA estimated that in 1985, wood heaters annually emitted 2.7 million tons of PM-10 and 7.4 million tons of CO. Of special concern is the portion of PM emitted by RWC devices that consists of a class of compounds referred to as polycyclic organic material (POM), some of which are known carcinogens. The 1600 tons per year of POM emitted by RWC devices accounts for the majority of POM emissions from all stationary sources (50).

In many areas of the country with PM-10 nonattainment problems, RWC devices account for a large fraction of the PM-10 emissions. These emissions result in high human exposure because they are emitted near ground level in residential areas -- unlike other traditional sources of PM-10 which often have tall stacks, large areas for dispersion, and are located in nonresidential areas. As discussed in Section 1.3, there are serious health effects associated with high concentrations of wood smoke from RWC emissions.

In addition to health effects from ambient (outdoor) concentrations, emissions from RWC devices result in degradation of visibility. Maximum visibility impairment is caused by particles of about 2.5 micrometers (μm) or less in size. Eighty percent of RWC emissions are less than 2.5 μm. RWC devices are a source of odor complaints and they create soiling from the deposition of particles on windows, vehicles, clothing, and buildings. Finally, RWC emissions are a major cause of indoor air pollution problems (51).

1.2.1.2 Causes of RWC Emissions --

Simply put, the PM-10 and CO emissions from RWC devices with enclosed fire boxes are the result of incomplete combustion. The control of the burning or burn time from any enclosed RWC device (i.e., wood stove), with the exception of pellet stoves, is accomplished by restricting the amount of air that can enter the fire box. This means of control creates an oxygen-starved combustion situation in which CO is formed and the PM-10 and organics are emitted as particles of incomplete combustion. A conventional wood stove -- typical of those sold before state and federal regulations were developed -- will convert to useful heat only about one half of the total potential energy available in the wood. The remainder is emitted through the chimney in the form of CO, condensible organics, or ash particles.

The key to reducing PM-10 emissions is to improve combustion efficiency by burning most of the unburned organics. This can be accomplished in two ways: (1) improved emission control technology for wood heaters, and (2) improved RWC operation and maintenance by consumers. These two approaches are discussed below.

1.2.1.3 Techniques for Reducing RWC Emissions --

Wood heater manufacturers have responded to requirements for reducing RWC emissions by either of two approaches: catalytic controls or noncatalytic design modifications. Both catalytic and noncatalytic approaches result in improved combustion efficiencies and in emission reductions -- as measured in the laboratory -- of between 70 and 90 percent of emissions levels characteristic of conventional wood heaters. Field testing of these models, however, has indicated more modest emission reductions. This is to be expected as one would not expect in-field operations to realize the same impressive reductions in emissions that are shown in the laboratory tests. Accordingly, control strategies should account for these differences.

Following is a brief discussion of both catalytic and noncatalytic control techniques and how consumers can reduce RWC emissions through proper operating and maintenance. The advent of high technology models and advanced designs has increased, not diminished, the role of operation and maintenance.

Control technology: catalytic--Introduced in the late 1970s, catalytic technology emerged around 1980 as a means of improving combustion efficiency and reducing creosote. It is the same technology used in automobile exhaust catalysts. The catalyst used on the combustor is a thin molded ceramic base coated with a slurry containing palladium or platinum that allows nearly all the organics and other combustible products in the smoke to burn at temperatures much lower than usual. Combustors are generally mounted above the primary combustion zone in the firebox, or retrofitted in the flue, where high temperatures are maintained but where flame impingement does not occur. When a combustor reaches its light-off temperature of about 450 degrees F, it causes the PM (mostly in the form of unburned organics) and the CO to burn, releasing heat, water vapor, and carbon dioxide. Generally catalytic wood heaters have achieved greater emission reductions in laboratory testing than have noncatalytic devices.

However, there are drawbacks to the use of catalytic combustors. They are not effective on fireplaces where the amount of combustion air is high relative to fuel burned. They deteriorate over time with use. They can be inactivated, temporarily or permanently, by burning the wrong fuels (such as coal or treated wood). Combustors can break from thermal or mechanical shock. Repeated cycles of heating and cooling frequently result in poorly fitting gaskets that allow untreated flue gas to bypass the gasket. Finally, it is easy for consumers to forget to engage their catalysts by closing the bypass damper after their fires are started. These are reasons why EPA's NSPS set an emission limit that encourages both catalytic and noncatalytic technologies. These are also reasons why some local RWC emission control programs that permit only certified wood heaters also require that in order for the permits to be renewed the units must be inspected periodically by a building inspector or other qualified professional.

Control technology: noncatalytic approaches--The term "noncatalytic" refers to RWC units that have secondary combustion chambers or other design modifications designed to control emissions. In secondary combustion, the first combustion area liberates unburned hydrocarbons because the lack of air restricts the combustion process. The unburned hydrocarbons and CO are then channelled to the area of secondary combustion where they are combined with a fresh source of air to enhance combustion.

Noncatalytic approaches include designs that increase firebox temperatures, increase turbulence for better mixing of air and fuel, increase the length of time combustion gases stay in high-temperature zones, introduce preheated secondary air, and combine these and other features.

Two other noncatalytic designs that differ significantly from the conventional wood heater are the high-mass heaters and pellet burners. High-mass heaters have hundreds of pounds of ceramic firebrick around a small fire chamber. An open, nonrestricted, hot fire heats the bricks as hot gases pass through a convoluted duct. After the fire has died down to coals only, the fire box is sealed and the heat is slowly released by the thermal mass for several hours.

Pellet-fired wood heaters burn small cylindrical compressed pellets made up of wood, wood chips, sawdust, and sometimes agricultural residue. Most pellet-fired heaters are freestanding units or central heaters; a few are fireplace inserts. The pellets, sold by the bag or in bulk, are manually loaded into hoppers attached to the heaters. An average hopper may hold more than 100 pounds of pellets. This is enough to heat a house for more than a day. The pellets are fed to the firebox by a motorized screw auger either on a timed basis, or as governed by a thermostat. This creates a drawback to pellet stove operation, however, in that these units will not operate, or not operate properly, if electric power is disconnected or if there is a power outage. Pellet heaters in general have the lowest emissions of PM-10 and CO, because combustion control is achieved by controlling the rate at which fuel is fed to the unit, rather than by controlling the availability of combustion air (51).

Improved operation and maintenance--In addition to improvements in the design of RWC devices, consumer practices significantly affect combustion efficiency and emission control. These practices include fuel use (e.g., burning only seasoned and dry firewood), stove operation (e.g., wood loading, avoiding starving the fire of air and thereby creating slow smoldering fires), and maintenance (e.g., replacing catalytic combustors and gaskets). The advent of the high-technology low-emitting catalytic and noncatalytic woodheaters has increased, rather than decreased, the importance of proper operation and maintenance. A well-designed wood heater operated by someone who does not make the proper adjustments or does not maintain the unit correctly will not achieve significant emission reductions.

The committee of industry, EPA, state government, and environmental participants that produced the NSPS for new wood heaters required that all wood heater operating manuals include certain operating and maintenance instructions. This regulation also makes it a violation of federal law for consumers to operate their wood heaters contrary to these instructions. These provisions could be enforced at the state and local levels if the regulation is adopted at that level. These provisions also indicate the importance of proper consumer operation and maintenance of RWC devices. The need for an informed wood-burning public is one reason why all state and local RWC emission control programs include a PA element.

1.2.2 EPA's Programs for Reducing RWC Emissions

EPA's strategy for reducing RWC emissions addresses both newly manufactured wood heaters and, for those areas with RWC emission problems, existing wood-burning units as well. These programs -- the wood heater NSPS and the PM-10 nonattainment SIP process -- are discussed below.

1.2.2.1 The Wood Heater NSPS: An Overview

Drawing upon the experience of similar programs in the States of Oregon and Colorado, a committee composed of representatives from the EPA, state governments, STAPPA-ALAPCO, test labs, consumer and environmental interests, and the wood heating industry developed an NSPS requiring all new wood heaters to be certified by EPA to meet emission limits. This regulation was promulgated in early 1988 (Federal Register, February 26, 1988). The final standard was agreed to by all participants in the regulatory negotiation and all parties agreed to support the final standard. The key features of this NSPS are summarized below.

- The standards control PM-10 emissions from new wood heaters manufactured on or after July 1, 1988, or sold on or after July 1, 1990. A second, more stringent, emission limit will take effect on July 1, 1990, for wood heaters manufactured on or after that date or sold on or after July 1, 1992. Small manufacturers (who produce fewer than 2,000 wood heaters per year) have an additional year to comply with the first phase of the standards.

- Open fireplaces, high mass heaters, boilers, furnaces, and cookstoves are not covered under these standards; the regulation primarily affects "airtight" woodstoves and fireplace inserts.

- The standards are being implemented under a certification program whereby the manufacturer submits a representative wood heater to a laboratory accredited by EPA to be tested according to a prescribed set of conditions.

- The certification is good for 5 years and may be renewed.

- Model lines which have been certified by the Oregon Department of Environmental Quality and which meet minimum burn rate requirements may be certified by EPA (for the 1988 standard only) without additional testing.

- Separate emission limits apply to catalytic and noncatalytic wood heaters as indicated below:

	Phase I (7/1/83)	Phase II (7/1/90)
Catalytic	5.5 grams per hour	4.1 grams per hour
Noncatalytic	8.5 grams per hour	7.5 grams per hour

- On or after July 1, 1988, all new wood heaters affected by the standards offered for sale will be labeled. Permanent labels will be used by enforcement personnel to determine compliance status. Temporary labels will be used by prospective purchasers to make comparisons in emissions and efficiency, and to determine the heat output of the various models.

- The standards will be enforced by label and parameter inspections of completed wood heaters and by emission audit tests on production line units.

- Manufacturers will be required to conduct two types of quality assurance programs -- one designed to ensure that components, dimensions, and materials of production are essentially the same as the model originally tested for certification, and another requiring emission testing at prescribed production intervals.

- Manufacturers are required to maintain records of certification testing data, QA program results, and production volumes. Accredited test labs are required to maintain testing records.

- Unlike most other NSPSs, relatively little of the implementation (i.e., the certification program and enforcement) will be delegated to the states.

1.2.2.2 The PM-10 Ambient Standard

The Clean Air Act requires that all areas of the country be in attainment of the NAAQS. In 1971, EPA established an NAAQS for particulate matter, measured in terms of total suspended particulates. On July 1, 1987, EPA promulgated a new NAAQS for only the particles with aerodynamic diameters of 10 micrometers or less (PM-10). Particles of this size are respirable and of greatest health significance (i.e., they penetrate deep into the tracheobronchial and alveolar regions of the lung). Respirable particles can damage the lungs and aggravate cardiopulmonary diseases.

The PM-10 NAAQS limits the amount of PM-10 in the air to 150 $\mu g/m^3$ when averaged over a 24-hour period and 50 $\mu g/m^3$ when averaged over an entire year. Only one exceedance of the 24-hour average is allowed each year for an area to remain in attainment of the PM-10 NAAQS.

RWC devices are one of many possible source categories of PM-10. Auto exhaust, wintertime road sanding, and industrial fugitive and point sources are others. The PM-10 NAAQS does not directly mandate RWC controls. However, of the 58 Group I areas (i.e., areas that have a greater than 95 percent probability of exceeding the PM-10 standard) in the country, approximately one-third were significantly affected by RWC emissions. Additional areas significantly affected by RWC emissions may be identified as the PM-10 monitoring program matures. The PM-10 SIP development process therefore is forcing many areas of the country to deal with the problem of RWC emissions from existing wood heaters.

Over time, the NSPS will result in reduced emissions from RWC as older high-emitting wood heaters are replaced by the certified low-emitting models. However, the relatively slow rate of improvement and concerns over the long term emission control performance of certified wood heaters requires that additional control measures be employed in many PM-10 areas with high RWC emissions.

1.2.2.3 Co-controls

The RWC emission control program for PM-10 compliance has the benefit of addressing other emissions from RWC devices. The concept of reducing other pollutants while addressing a target pollutant (in this case PM-10) is called "co-control." Catalytic and noncatalytic technology as well as improved operating and maintenance reduces CO and the toxic constituents. The extent of co-control may not be proportionate with PM-10 reduction for any specific technique (e.g., catalytic devices are proportionately more effective for reducing CO than are non-catalytic devices). Nevertheless, it is generally true that a technique that reduces RWC PM-10 emissions will also reduce CO and toxic air pollutants as well. The concept of co-controls can be used to help persuade the public to accept local PM-10 RWC control measures.

1.3 HEALTH EFFECTS FROM RWC EMISSIONS

Research conducted in recent years has dispelled the popular notion that wood smoke is a relatively innocuous substance. Appendix D is an EPA "Fact Sheet" on health effects from RWC emissions. Several areas have found that if the health effect information is communicated clearly and convincingly to local policymakers, the press, and the general public, the RWC emission control program becomes more acceptable. A simple but effective approach is to first show the levels of RWC concentrations and emissions in the community (as compared to all PM-10 sources and as compared to the NAAQS) and then to present the health effects data -- perhaps with the assistance of a health professional.

In the State of Washington, where the Department of Ecology and the Puget Sound Air Pollution Control Agency have made a special effort to communicate to the public and to state legislators the health effects from exposure to wood smoke, the public and legislative support for a stringent set of controls has been strong. Staff members from these two agencies have teamed with researchers at the University of Washington to investigate the health effects literature. The following is a summary excerpt of part of their findings (42).

> Wood smoke is a complex mixture of substances which individually and collectively are associated with both chronic and acute health effects. These substances include PM-10, CO, aldehydes, nitrogen oxides, and polycyclic organic materials (POM) specifically including polycyclic aromatic hydrocarbons (PAH).
>
> - PM-10. Fine particulate matter is of concern to public health because this size particle has been shown to be readily inspired into the lungs. The finest particles deposit more deeply in the lung where some can remain indefinitely and cause morphological and biochemical changes. Several studies suggest that the declines in lung function that are associated with episodic exposures to PM-10 occur rapidly and persist for up to two to three weeks before recovery.
>
> - Carbon monoxide (CO). The current outdoor standard for CO is 9 parts per million (ppm) for an 8 hour period or 35 ppm for any given hour. CO combines with hemoglobin, thus decreasing the oxygen carrying capacity of the blood. One physiological response to CO is the increased incidence of angina among persons with cardiac disease.
>
> - Aldehydes (including formaldehyde and acrolein). Exposure to formaldehyde at concentrations above 0.4 ppm has been associated with upper airway irritation, headaches, and other neurophysiologic dysfunctions. Also, a federal panel concluded that formaldehyde should be presumed to pose a carcinogenic risk to humans. Acrolein, another aldehyde found in wood smoke, is an even more potential eye and respiratory tract irritant. Wood burning has been shown to be a major source of aldehyde pollution, with emission levels comparable to those from power plants and automobiles.
>
> - Nitrogen oxides (NO_x). At high concentrations, NO_x is known to cause accumulation of fluid in the lung (edema) and scarring in the lung (fibrotic changes).
>
> NO_x can have both acute and chronic effects. Studies have shown that children from homes with gas cooking stoves (which emit NO_x) experience a greater frequency of respiratory illness than do children from homes with electric stoves. However, consistent lung effects in children due to NO_x exposure have been difficult to characterize.
>
> - Polycyclic Aromatic Hydrocarbons (PAH) are complex hydrocarbons that are formed during the combustion of many organic materials. Many PAH compounds have been shown to be carcinogenic in animal studies.

Studies have shown that workers with 15 years or more exposure to coke-oven emissions have a 16-fold excess risk of developing lung cancer compared to the general population. Wood smoke contains many of these same PAH compounds primarily adsorbed onto the PM-10 that is emitted. One of the PAH compounds, benzo(a)pyrene, is a proven animal carcinogen.

Airborne wood smoke fumes, collected both inside and outside homes using wood stoves, were analyzed for their toxic properties and were shown to contain mutagens (substances that cause changes in the genetic material) which produced up to 100 times as much mutagenic activity as some well-known carcinogens. In addition, the mutagenicity of wood smoke increases up to ten times when smoke interacts with other pollutants (such as NO_x or ozone) in the atmosphere. This is of special concern in urban areas where there are significant sources and quantities of other pollutants (40). Other studies reported that emissions from both traditional- and advanced-technology wood stoves caused sister chromatic exchange (SCE) -- chromosomal defects -- in mammalian cells. Even though the newer stoves produced less PM-10 and CO, in the chromosomal tests the emissions from these stoves were as mutagenic as emissions from a conventional stove.

In addition to the health effects described above, there are other possible chronic health effects due to exposure to substances present in wood smoke. They include:

1) increased airway resistance (difficulty in breathing);

2) decreased vital capacity of the lung;

3) increased susceptibility to respiratory infection in children;

4) increased respiratory symptoms of cough, phlegm, and dyspnea (shortness of breath) in people with chronic obstructive pulmonary disease; and

5) aggravation of asthma.

Although EPA's focus has been on ambient (i.e., outdoor) air quality, wood smoke is particularly troublesome to health researchers because it is a major contributor to indoor air pollution. Indoor air pollution from both airtight and non-airtight stoves produces measurable PM-10 and PAHs within the home. One study showed that emissions from non-airtight stoves resulted in indoor concentrations of up to 650 $\mu g/m^3$ of PM-10. (The new EPA standard for PM-10 is 150 $\mu g/m^3$ for a 24-hour period.) Airtight stoves, however, do not contribute as much to indoor air pollution.

EPA has prepared a fact sheet that presents a concise review of the potential health effects from wood smoke. EPA recommends that this fact sheet, contained in Appendix D, be used for public awareness purposes in state and local programs.

1.4 APPLICATION OF EMISSION CREDITS FOR PM-10 SIPS

Most of the remainder of this report deals with a variety of RWC emission control measures. These measures are discussed by major categories: public awareness, measures that improve wood burning performance, measures that reduce the use of wood burning devices in a community, and curtailment. Each emission control measure is described, with particular attention paid to existing programs where a particular measure has been adopted and implemented for the control of RWC emissions. In addition, the report describes the factors that determine the effectiveness of each control measure in reducing or limiting PM-10 emissions. Finally, an emission reduction credit is recognized for each program element.

As discussed below, the emission credits represent the reduction in PM-10 emissions expected to result from the adoption and implementation of a particular program element. An example describing the application of these emission reduction credits is contained in Appendix E.

1.4.1 PM-10 emission reduction credits

Credit defined. A PM-10 emission reduction credit is the measure of reduction in PM-10 emissions from RWC devices that EPA projects would be accomplished through adoption and implementation of one of the program elements described in this report. The emission reduction credits are applied to the inventory of PM-10 emissions from RWC devices in a community or airshed to determine the reduction in PM-10 emissions from individual sources, as well as the reduction in emissions community-wide.

The emission reduction credits are planning tools that can be used by a state or local air quality agency in designing an RWC emission control program. Through the use of the credits identified in this report, an agency can investigate alternative SIP regulations and determine which combination of program elements will reduce existing or projected PM-10 emissions from RWC devices by an amount that is sufficient to lead to attainment and maintenance of the NAAQS for PM-10.

These suggested credits are not designed to be applied automatically to different types of programs or regulations that are included in a SIP. Rather, EPA recognizes that the effectiveness of RWC control programs and regulations can vary widely, depending on a number of factors such as the strength of the State or local agency's implementation program, the characteristics of the wood typically used for fuel in the area, and the nature of any public education programs. The suggested credits included in this guidance, therefore, should be viewed as the starting point in assessing the effectiveness of RWC control programs and regulations. State and local agencies should evaluate their programs or regulations in light of the discussions in this guidance (such as Table 5-9). The application of credit must be accompanied by a justification of the credit claimed for their specific program or regulation. All justifications and ascribed credits shall be subject to review.

Derivation of credits. The emission reduction credits identified in this volume are derived from two sources. The first type of credit is based on actual measurements that have been made in the field or laboratory to estimate a change in stove emissions. Two examples of this are the changeover to Phase II stoves and the field surveillance of curtailment program effectiveness. In such cases, the credits were based on the measurement data. The technical review committee interpreted the measurement data in the context of representativeness of the data and of the equipment or situation they represent when making their final determination of credits.

Where the information available was limited, a combination of theory, available data, enforceability, determinations, estimates of the percentage of homes or appliances affected, and the collective judgement of the technical review committee was used to establish the credits. The programs where effectiveness was estimated at ≤ 5 percent were of this type. The discussions found in Sections 3, 4, and 5 of this document contain more information on the derivation of credits for specific program elements.

Application of credits. Depending on the measure being described, a PM-10 emission reduction credit may be expressed as:

- a reduction in current levels of emissions from existing RWC devices,
- a reduction in growth in emissions from new RWC devices, or
- a reduction in PM-10 emissions from both current and expected emission levels.

This distinction is due to the fact that different program elements are applicable to different types of RWC devices.

Control measures that apply only to new RWC devices that are purchased and installed in a community restrict the rate of growth in PM-10 emissions, but do not affect PM-10 emissions from existing RWC devices. The current EPA certification program is an example of a measure that restricts emissions from new sources but does not directly affect emissions from existing sources.

On the other hand, control measures that apply only to existing RWC devices reduce current levels of emissions, but do not limit emissions growth. The requirement that retrofit control devices be installed on existing devices, as discussed below in Section 3, would reduce existing emissions but would not affect emissions growth. Finally, measures that are applicable to both new and existing RWC devices, such as a firewood moisture ordinance, reduces existing emissions while restricting emissions growth.

Characteristics of emission reduction credits. As used in developing SIP programs for RWC emissions, several facets of PM-10 emission reduction credits should be recognized. First, these credits are EPA's best estimate of the effectiveness of the control measures described in reducing PM-10 emissions. These credits will be recognized by the Agency where the program proposed by the state or local agency conforms to the program elements described in this manual. However, these credits are not intended to operate as limits on what a state or local authority can propose or adopt. Instead, these credits are meant to encourage programs to go beyond the requirements described for the individual program elements, to make these programs more effective in controlling PM-10 emissions, and to qualify for greater emission reduction credits than listed in this volume.

Where evidence or data are presented to support a greater (or lesser, in extenuating circumstances) rate of PM-10 emission reduction for a particular program element, EPA may, at its discretion, revise the credit recognized for that program element. The final judgment on the level of emissions reduction recognized as a credit against current or future PM-10 emissions, however, rests with the EPA regional offices. Such determinations should begin prior to SIP submittal.

Program evaluation. Second, the importance of evaluation in implementing these programs should be emphasized. Each RWC emission control program should include specific provisions for determining the program's effectiveness in achieving the expected emission reductions. Evaluation is particularly important for those elements that are based on voluntary compliance with a control program, such as voluntary curtailment programs described in Section 5, but are also necessary to measure the effectiveness of mandatory programs as well. This requirement could mean conducting follow-up interviews of RWC device owners, as described in Appendix A, as well as tracking changes in ambient levels of PM-10 in the community as control measures are implemented.

Enforceability. Similarly, any program calling for mandatory controls on PM-10 emissions from RWC devices should be clearly enforceable. In the descriptions in Sections 3 and 4, no credits are recognized for certain program elements because these measures are generally unenforceable. This includes, for instance, a prohibition on the resale of used, uncertified RWC devices. Because existing regulatory programs ban the sale of these devices through retail channels, the resale of used devices would have to take place through informal transactions such as flea markets, newspaper classified advertisements, and personal contacts. The nature and variety of these transactions would make enforcement of a prohibition against resale expensive in both time and effort, rendering meaningful enforcement impractical and diverting state and local agency resources from more productive measures. However, unenforceable measures do have some value as a deterrent.

Credits for new measures only. In calculating the emission reduction credits that will be recognized for an RWC emission control program, credit will only be recognized for program elements that go beyond any existing controls that a state or local agency may be implementing. The emission reductions achieved through the application of existing RWC control programs is included when calculating current emission levels, as described in Appendix A. Therefore, to recognize credit for additional reductions based on those same control programs would result in credit being given twice for the same program element, once in calculating current emissions and again in projecting the effectiveness of the new PM-10 emission control program.

1.4.2 Priority of emission control measures

A technical committee of EPA regional and headquarters personnel, as well as representatives of state and local air quality agencies, met to discuss a draft of this report. One of the areas of consensus that emerged from this meeting was the need to prioritize RWC emission control measures according to their long-term effectiveness and the reliability of the measures to actually reduce RWC emissions.

The technical review committee believes that state and local policy-makers should distinguish between measures that rely on the good will of the community and those that can be readily enforced; and between measures that offer a temporary solution versus those that result in a long-term reduction in emissions. The committee concluded that, in general, the following hierarchy of control measures exists:

- Measures that result in fuel switching (e.g., from solid fuels to natural gas) and/or overall conservation are the most effective and the most certain to achieve the goals of reduced RWC emissions.
- Measures that result in improved combustion performance as a result of technology (e.g., mandated upgrade from conventional devices to EPA Phase II certified stoves) are the next most effective and reliable category of measures.
- Measures that achieve temporary emission reductions, most notably episodic curtailments, are less desirable long-term strategies for addressing the RWC emission problem.
- Measures that rely on public awareness and upon voluntary cooperation are less desirable than either fuel switching or the technology-based measures. Although the committee believes that the role of the consumer in operating and maintaining RWC devices is critical, the committee believes that voluntary and education-based measures are difficult to enforce and therefore are not as reliable and consistently effective as the "technical fixes."

SECTION 2

PUBLIC INFORMATION AND AWARENESS

The success of any RWC emission control program depends largely on an effective public awareness (PA) program element. The PA program element affects the degree of public acceptance of all other program elements. A PA program element serves two essential purposes: (1) it acquaints citizens with details of the RWC control regulation (or ordinance), their responsibilities under the ordinance, and the justification for the ordinance while (2) providing persuasion and reinforcement of the issues and principles behind the ordinance. Effective compliance with RWC emission control requirements is possible only through an informed and supportive public.

This section (1) points out the importance of tailoring a PA program element to the community's values and attitudes, (2) the goals of a PA program element, (3) how to communicate the messages, (4) a description of three levels of PA program elements, and (5) tracking the effectiveness of PA program elements.

2.1 ATTITUDES TOWARD WOOD HEAT

Variations in PA program elements reflect differences in community attitudes and values. These, in turn, have a direct bearing on the way a specific PA program element addresses its goals. For example, there are areas where wood heat is a mainstay of rural heating habits and is perceived as a "constitutional right". The issue of the individual's right to burn has implications for how a PA program should approach its message for that area. Obviously, the PA program element would be more effective at overcoming entrenched resistance to regulation by adopting a stance that emphasizes the benefits of more efficient and cleaner burning RWC devices rather than threats of sanctions for failure to attain the standard.

Another example of public attitudes is found primarily in winter recreational areas such as the ski resort towns of Colorado. Unlike the largely rural, wood-burning population in parts of Washington and Montana, residents in resort towns must contend with seasonal fluctuations of tourists for whom wood-burning stoves and fireplaces are a fundamental part of an expensive vacation amenities package. The guests have little vested interest in the long-term effects of RWC emission problems in the community as a whole.

In summary, policymakers must take into account community attitudes and values in developing the overall RWC emission control plan and specifically the PA program element. PA program elements must also be targeted to different "publics." In addition to the general wood-burning public, depending on the mix of other program elements, a PA program element may target real estate agents, woodstove dealers, or home builders.

2.2 PA PROGRAM GOALS

The general goals of the PA program elements currently in place are similar: (1) to communicate the potential health risk (as well as threats to visibility and tourism) associated with wood smoke so that the community will support other program elements and (2) to promote better wood-burning practices or selection of alternative heating systems. (Few areas rely on PA as a stand-alone program element to achieve PM-10 attainment.) Although these basic goals are shared by most PM-10 programs, the particular approach that the PA program element takes to promote those goals can be quite varied.

2.2.1 Health Risks

A particularly effective approach to promoting RWC emissions control is for a PA program element to stress the health risks from wood smoke.

Of the areas surveyed, the Puget Sound PA program element has taken one of the most aggressive positions regarding PM-10 health effects. Working with a well-informed public information staff, the news media, and the medical community, the PA program element has focused on air toxics from wood smoke. This program element makes its case in three ways.

- An ongoing public information effort has focused on drawing a parallel between wood smoke and cigarette smoke -- both in terms of associative respiratory problems and social responsibility. *Wood Heat, Wood Smoke and You* (53) discusses the major fumes found in wood smoke and their health effects. The pamphlet even states explicitly that "many of these compounds are also found in cigarette smoke, a known cause of lung cancer and respiratory and cardiac diseases."
- Individually and collectively, physicians are speaking out against the effects of wood smoke. The PA program element has publicized anecdotal links between bad air quality related to wood smoke and increased incidence of pulmonary disease.
- The program element makes the health effects more immediate and personal by showing that wood smoke health risks begin in the home. This approach dispels the misconception that wood smoke is only a problem where it is visible. This approach is a persuasive rebuttal to the belief that wood smoke, as long as it is outside the home, affects only those who are breathing it out there and cannot harm the people indoors. Their publication, *Wood Heat*, (45) provides health and safety information about the effects of breathing indoor wood smoke.

2.2.2 Operation and Maintenance

Persuading owners of RWC devices to change the way they operate their stoves is an effective means to control PM-10 emission levels. As part of that effort, PA program elements educate the public about better burning practices, and convince owners of RWC devices to abandon poor wood-burning habits. The PA program element must take into account the prevalent burning patterns and practices for a given area in order to know how to target those habits that are unacceptable. The use of a survey, as described in Appendix A, can provide this information. Such a survey is also useful in selecting and developing program elements to mandate improved wood-burning performance (see Section 3).

2.2.2.1 Heating Fuels and Practices --

Most PA program elements try to educate the public first about which fuel sources are acceptable and which provide the highest heat efficiency output. For example, Washoe County has a pamphlet that discusses fuel choice, fire preparation and maintenance, and firewood characteristics of the area.

Most RWC emission control programs have a fuel source component that stipulates which fuel sources are allowed to be burned in RWC devices (e.g., Washington's regulation even requires wood to be well seasoned [no more than 20% moisture content]). These ordinances rely on PA efforts to help the public make informed choices about their fuel sources. Also, by pointing out the harmful by-products released when nonapproved fuel sources (e.g., garbage, treated wood) are burned in RWC devices, the PA program element reinforces the health issues associated with wood smoke.

An effective PA program element links heating practices with selection of heating fuel. It is a natural alliance since the quality and efficiency of the wood being burned affect how it is burned. For example, hardwoods are denser than softwoods and release more energy per pound of wood when burned. Therefore, a RWC device needs fewer pieces of hardwood to heat an area than if it were burning softwoods.

Education about heating practices focuses on optimum burning times and how to burn properly. The first issue is straightforward: wood burners are told not to burn overnight, while they are away, or anytime the fire is left unattended. (Overnight burns are usually accomplished by very restricted air supply settings which result in poor combustion and high emissions.)

Unfortunately, the two most common burn periods -- early morning and early evening -- frequently coincide with the time of day when atmospheric conditions are ideal for inversion and air stagnation. This coincidence is almost unavoidable, since the two burn periods reflect the activity patterns of most households; i.e., warming the house after a cold night and again when the household members arrive home in the evening.

Knowing how to burn properly requires a basic understanding of how a wood stove works. The NSPS requires explicit information in owner's manuals regarding the operation of the specific appliance in order to achieve low emissions. Brochures that address proper burning techniques emphasize the importance of burning small, hot fires. PM-10 opacity limits usually accommodate this emphasis by allowing for a brief period when the opacity is higher as wood burners build the initial hot fire.

Proper burning also involves careful monitoring of the air/fuel mix in a stove. Turning the damper too far down or allowing fires to smolder from a lack of air reduces heating efficiency and causes the worst wood smoke pollution. An effective PA program element explains the simple "physics" of how wood stove operators can ensure a proper air/fuel mix, and reminds them that different stove types -- especially catalytic stoves -- are designed to burn most effectively when dampered down. Many brochures go on to show how poor burning is one of the easiest practices to monitor simply by observing the amount of smoke exiting the chimney and adjusting the air/fuel mix accordingly. Pointing out that smoldering fires greatly increase creosote build-up in chimneys serves to reinforce the safety, health, and economic issues of wood smoke.

2.2.2.2 Stove Types --

As reported earlier, the State of Washington equates the selection of an RWC device with the broader issue of lifestyle. Although most of the brochures collected as part of the description of PA program elements do not address RWC device selection, the publication *Wood Stoves, Wood Smoke and You* (53) discusses catalytic versus noncatalytic stoves and pellet stoves. *Wood Heat* (45) treats wood stove material, types, and overall relative efficiencies at some length. Most of the PA material allows prospective wood stove buyers to draw their own conclusions about which stove is most appropriate for their lifestyle, and how that stove choice may affect the degree of compliance with the applicable PM-10 program.

Overall, PA efforts could be more persuasive at helping buyers choose an efficient RWC device by recommending that they consider only certified units or pellet stoves. EPA's *Buying an EPA-Certified Woodstove* (52) is another useful handout addressing woodstove selection to include in any PA program element.

2.3 COMMUNICATING THE PA PROGRAM ELEMENT

There are three categories of media for conducting public information/PA efforts: print (primarily newspapers and brochures), broadcast (TV and radio), and public contact/public education (education classes and public hearings). The most effective PA program element uses a combination of these three media which, when coordinated, forms a comprehensive and potent means of ensuring the best chance for meeting PA goals. Table 2-1 gives the relative strengths and weaknesses of each medium.

One exception to the multimedia approach is found in Okanogan County, Washington, which relied exclusively on town meetings and public hearings. The decision to present elements of the PM-10 ordinance draft only through public meetings was based on the controversy such legislation was anticipated to generate. Because of the area's antiregulatory bias, county officials decided this approach would help the legislative process appear to be less arbitrary by presenting the ordinance as a democratic process. This approach was not wholly successful at reducing tensions. B. Banner reported a volatile and sometimes violent public hearing episode during one of the ordinance's several revisions (1).

Like Okanogan County, Steamboat Springs (Routt County), Colorado, has not developed any printed material, but has relied primarily on public contact to publicize ordinance-related information. The rationale behind their approach is the belief that most ski tourists, the predominant users of wood stoves and fireplaces, are unlikely to read brochures.

TABLE 2-1. STRENGTHS AND WEAKNESSES OF THREE DIFFERENT PUBLIC INFORMATION MEDIA

	Strengths	Weaknesses
Print	• Customized to address specific issues/audiences • Generic messages can be shared among regulatory agencies and communities • Most economical to produce and distribute	• Can be deliberately ignored easier than electronic media • Cannot be revised or distributed as quickly as electronic media
Broadcast	• Immediacy • TV has visual impact that other media lack • Free PSAs may be available	• Relatively expensive to produce and distribute • Some mountain valleys may have poor reception
Public Contact/ Public Education	• Allows for immediate response to public questions • People tend to respond more favorably to public contact • Most effective as an educational tool • Engenders a democratic approach by allowing for diverse group participation	• Overdependence on voluntary attendance • Has limited long-term impact • Presents logistic problem with schedules of speakers, audience, and meeting places

The three types of PA media differ in their degree of impact, from "passive" (broadcast) to proactive (public contact/public education). Of the areas surveyed, Washington State has one of the most comprehensive PA program elements, especially in the Seattle/Puget Sound corridor. As described above in the discussion of PM-10 health effects, Washington enlisted the help of the news media to promote strong public acceptance of the state's PM-10 ordinance. No known negative news stories, features, or editorials have been written about the ordinance. The widespread media support is attributed to two factors: (1) a strong initial effort to garner press support by holding one-day workshops and press conferences that included articulate health experts to discuss PM-10 health risks, and (2) an ongoing public information effort that focuses on the air toxics aspects of wood smoke. Rather than attacking PM-10 problems initially as a purely environmental compliance problem, Washington has successfully emphasized the health risks of wood smoke as an issue that the news media could then present more objectively to a wider audience.

The following is a discussion of the three media -- direct public contact, broadcast (or electronic), and print.

2.3.1 Direct Public Contact/Public Education Medium

2.3.1.1 Seminars and Workshops --

Washington's PA program element also is an example of an active public education program. Coordinating classes with the Washington Energy Extension office, the state employs wood smoke specialists to conduct seminars and workshops on different aspects of wood heating. Through class curricula developed by Washington's Department of Ecology (DOE), the major message of the workshops is for each class participant to reconsider, after hearing the facts about RWC, the practicality of buying or continuing to use an RWC device. The degree of receptivity to the ideas presented in the seminars is gauged by having class participants evaluate the course. These evaluations provide the only solid data on the effectiveness of this particular type of PA program element. M. Nelson reported that some of the class indicated they had decided not to buy an RWC device based on the information presented in the seminars (20).

2.3.1.2 Community Group Programs --

The power of community group programs, as in Klamath County (see below), should not be underestimated. In Washington State, residents formed a non-profit organization, known as Citizens Against Woodstove Fumes (CAWF), that played a major role in the state's 1987 RWC control legislation. CAWF publishes a newsletter, and has an advisory board comprised of an environmentally diverse background of professionals (33).

Officials with Washington's PA program element believe that getting the public to decide against buying their first wood stove has the greatest potential to contribute to reduced PM-10 emissions.

Public education similar to the seminar workshop format used in Washington can be made to address specific issues (sizing a wood stove, looking at new technology stoves) or address broad concerns (discussing a proposed PM-10 ordinance, wood heat vs. other heating sources). Yet each approach has the same limitations that make determining the ultimate effectiveness and verifiable value of a PA program element extremely difficult. Namely, there is no way of determining, over any meaningful period of time, to what extent improved, long-term wood heating habits can be attributed to the knowledge gained through public education.

2.3.1.3 Stove Fairs --

Another approach to public education has been community-sponsored stove fairs that provide a forum for government and the private sector to educate the public on new RWC technologies (e.g., catalytic, certified, and pellet stoves). In Colorado, the towns of Crested Butte and Telluride organized a trade show where retailers of RWC devices could present and discuss their latest product lines. The advantage to this approach is that it allows private businesses to be involved in the PA program element and promotes a better understanding between the local regulatory agency and the industry that may perceive itself to be threatened by PM-10 legislation.

2.3.1.4 Speakers Bureaus --

Klamath County, Oregon, has an extensive PA program element that uses a speaker's bureau approach. The Klamath County Health Board has developed a list of organizations that would be likely audiences for public speaking forums on RWC issues. The Board has also established an industrial education program that targets employers with printed material and lectures. The Board then uses the roster of employees of the different industries as a base for neighborhood meetings.

The neighborhood meeting approach involves informal, person-to-person information sessions in private homes to discuss and present material on all topics of wood heating. These meetings are held in the neighborhoods in areas that experience the poorest air quality conditions, and are scheduled to avoid conflicts with popular television programs.

2.3.1.5 Public School Programs --

Klamath County has two RWC PA program elements that will begin in the public schools by August 1989. The first is the "compliance volunteers program," which presents, through student-oriented projects, several wood-heating issues (fire prevention, pollution, health, wood seasoning and burning, and the PM-10 compliance program). T-shirts displaying related messages and newspapers that the children write and design themselves are also part of that program element.

The second school-related program will be the "Breath of Life" fair that combines the ideas of an RWC device trade show with public information about wood heating. The health board plans to make the program a collaborative effort of school administrators, health board staff, stove retailers, and local civic groups. The key element to the "Breath of Life" fair is its emphasis on community involvement. Klamath County's ambitious and comprehensive slate of PA program elements is exemplary in its breadth of scope for long-range planning and diversified resources for achieving PA program element goals.

2.3.2 Broadcast Medium

The broadcast medium (TV and radio) is the second most common vehicle for disseminating public information about PM-10 issues. Every area surveyed reported the use of TV and radio "spots" to various degrees of sophistication.

2.3.2.1 Radio-TV Spots --

As it demonstrated with its extensive public contact programs, Washington has invested much of its PA program element in using radio and television. In addition to the normal spots run as radio and TV public service announcements (PSAs), the state produced a public access television program as an educational tool. Similarly, the Butte-Silver Bow, Montana Health Department produced a radio talk show to address topics relating to wood heating and the local PM-10 ordinance.

2.3.2.2 Telephone Hotlines --

Although not a broadcast medium in the technical sense, the telephone is another type of electronic media used to inform the public of different aspects of an area's PM-10 program. The telephone, through the use of "hot lines," becomes a de facto PA medium by coordinating public information with curtailment notices (see Section 5 for a detailed discussion of telephone hot lines and their use during curtailment episodes). By including relevant information about wood smoke/heating in the recorded messages along with notices of curtailment, regulatory agencies have reinforced the connection between poor wood-burning practices and their immediate consequences (i.e., poor air quality that leads to curtailment).

2.3.3 Print Medium

Of the three ways the different RWC emission control programs promote public information, the print medium has been the most popular, with few exceptions. Largely because of the many possibilities for distribution, the printed message is the linchpin of almost all PA program elements. Its two great advantages -- diversity and specialization -- have been fully exploited by many of the areas surveyed. Whether through the most common forms of publications (newspapers and brochures) or through more novel approaches (posters, restaurant placemats, utility bill inserts), the print medium has the greatest potential to reach the broadest yet specific target audience. Table 2-2 lists all the printed material received from the 30 different agencies we interviewed.

When compared to the costs of public speaking efforts, printed information is very economical, making the production and distribution of highly focused messages a powerful tool. For example, in Pitkin County, cards alerting tourists to Aspen's wood smoke problems have been printed and are placed in special racks in the condominiums and restaurants most frequented by tourists. Public awareness of how Aspen's odd/even burn day system works is especially crucial in a transient wood-burning population, and information cards posted in hotel rooms or distributed at the registration desk are an ideal way of informing hotel clientele.

2.3.3.1 Newspapers --

Publicizing wood-heating information in the newspapers is effective largely because newspapers usually enjoy a wide circulation and are highly visible. The fluid nature of newspaper layout allows for strategically placed items of information -- from front page forecasts of the day's air quality or the notification of that day's curtailment episode, to detailed articles or regular columns scattered throughout the paper that discuss selected wood-heating topics. Daily (and even weekly) newspapers that carry some form of PM-10-related information serve as a regular reminder of the existence of a community's PA goals and efforts towards meeting those goals. Over time, this awareness can become a conscious part of a newspaper's readership.

TABLE 2-2 PRINT MEDIA USED IN PUBLIC AWARENESS PROGRAMS

Area	Title of Publication	Topics Discussed
California	(1) *Residential Woodstoves and Fireplaces*	• Health risks • Stove sizing • Better heating practices • Curtailment responsibilities • EPA Wood stove regulations
	(2) *Wood Heating and Air Pollution*	• Fuel choice • Firewood preparation • Better heating practices
Colorado Aspen	(1) *Tips on How to Burn*	• Better heating practices • Temperature inversion signs
	(2) *A Burning Issue*	• Temperature inversion signs • Wood smoke pollution • Comparison of pollution levels from wood heat vs. oil heat • Cost of heating with wood • Better heating practices
	(3) *Welcome to Aspen*	• Tourists awareness of temperature inversions
	(4) *Notice to Aspen Property Owners*	• Odd/even burn days system responsibilities
Idaho	*Let's Clear the Air!*	• PM10 regulations • Stove upgrade program • Curtailment responsibilties • Better heating practices

(Continued)

TABLE 2-2 (CONTINUED)

Area	Title of Publication	Topics Discussed
Montana Missoula	(1) *Heating With Wood*	• Sizing a wood stove • Better heating practices • Health risks
Lewis & Clark	(2) *Air Pollution in Helena*	• Sizing a wood stove • Better heating practices
	(3) *Good Neighbors Under One Roof*	• Proper wood cutting and storing
	(4) *How to Tell if You Are Burning Hot, Smokeless Fires*	• How to use a stove thermometer to monitor wood stove temperatures
	(5) *Please...For a Healthy Helena* (Designed to slip over doorknobs)	• Better heating practices
	(6) *Air Pollution Affects Our Health*	• Health risks • Curtailment responsibilities
	(7) *Everything Has Its Price. Even Wood*	• Provides a worksheet to estimate total cost of wood heat vs. gas heat
	(8) *Turn Up the Gas!*	• Benefits of gas heating and the Montana Power Co.'s rebate program
	(9) *It's Time for the Change to Natural Gas*	• Benefits of gas heating and the Montana Power Co.'s rebate program
Butte-Silver Bow	(10) *Wood Heat*	• Health risks • State PM10 regulations • Advantages and disadvantages of wood heat • Relative pollution emissions and how to reduce them • Types of wood stoves • Better heating practices

(Continued)

TABLE 2-2 (CONTINUED)

Area	Title of Publication	Topics Discussed
Oregon	(1) *Certified Wood Stoves*	• Consumer's guide to selecting Oregon-certified wood stoves
	(2) *Sizing Wood Stoves*	• How to select appropriate wood stoves
	(3) *Catalytic Wood Stoves*	• Consumer's guide to selecting and operating catalytic wood stoves
	(4) *The Monitor*	• Curtailment responsibilities • Health risks
	(5) *Reduce Pollution*	• Better heating practices • Proper wood storage habits
	(6) *Burn Wood Better*	• Better heating practices • Sizing wood stoves • Comparison of heating values of different types of wood
Washington (Energy Extension Service)	(1) *Wood Heat, Wood Smoke and You*	• Health risks • State PM10 regulations • Advantages and disadvantages of wood heat • Relative pollution emissions and how to reduce them • Stove types • Better heating practices
	(2) *Wood Heating and Air Pollution*	• Fuel choice • Firewood preparation • Better heating practices
	(3) *Focus on Washington's Wood Stove Regulation*	• State PM10 regulations • Health risks
	(4) *Using Wood Heat: Advantages and Disadvantages*	• Costs of heating with wood vs. other sources of heat • Advantages and disadvantages of wood heat
	(5) *Adding a Catalytic Combustor to an Existing Woodstove*	• Consumer's guide to buying and using a catalyst

(Continued)

TABLE 2-2 (CONTINUED)

Area	Title of Publication	Topics Discussed
Washington (Energy Extension Service)	(6) *Guide to Sizing Wood Stoves*	• Selecting appropriate size wood stove
	(7) *Indoor Air Pollutants—Combustion Products*	• Health risks
Puget Sound Air Pollution Control Authority	(8) *The Town of Firecrest: Washington's Model Clean Air Community*	• Health and safety risks • Curtailment responsibilities • Better heating practices
	(9) *Life, Health and Woodsmoke*	• Better heating practices • Health, environmental, and safety risks • Relative costs of heating with wood
	(10) *Wood Smoke Facts*	• State's PM10 regulations • Health risks
	(11) *Health effects of wood smoke: A summary statement*	• Health risks
	(12) *CAWF Newsletter*	• Health and environmental risks • State's PM10 regulations
Nevada Washoe County	(1) *Green, Yellow, Red*	• Curtailment responsibilities • Temperature inversions
	(2) *Burning Issues*	• Fuel selection and storage • Better heating practices • Comparison of heating values of different types of wood
	(3) *Wood Stove Appliances*	• Answers common questions about wood stoves and real estate transactions
	(4) *A Woodburner's Guide*	• Selecting appropriate size wood stove • Installation and maintenance • Better heating practices • Proper wood storage habits

(Continued)

TABLE 2-2 (CONTINUED)

Area	Title of Publication	Topics Discussed
Nevada Washoe County	(5) *New Rules for Buying and SellingWood Stoves*	• Consumer's guide to buying wood stoves • Curtailment responsibilities
U.S. Department of Energy	(1) *Buying a Wood-Burning Appliance*	• Consumer's guide to selecting different types of solid fuel devices
	(2) *Wood Fuel*	• Firewood preparation, storage, and relative heating values
	(3) *Operating a Wood Burning Appliance*	• Better heating practices • Proper chimney maintenance • Environmental and safety risks
U.S. Environmental Protection Agency	*Buying an EPA-CertifiedWoodstove*	• EPA's wood stove regulations • Sizing and selecting the appropriate wood stove

2.3.3.2 Brochures --

Brochures are the most common type of printed medium community agencies use to publicize RWC emission control information. Figure 2-1 shows examples of the variety of brochures available to owners of RWC devices. Because of mutually acceptable goals and methods for reducing PM-10 emissions from wood smoke, the basic information found in one state's pamphlet or brochure is often used by another community to educate its public. Some areas such as Washington State have produced numerous brochures and fact sheets of relevant information that are suitable for reprinting by smaller municipalities with limited budgets. As an alternative to using PA material developed by an in-house staff or relying on previously published material, Boise, Idaho, worked with an ad agency to produce its brochures about air pollution in Boise.

Brochures are especially useful since they can treat any single topic in as much detail as is necessary. Oregon's Department of Environmental Quality has a series of brochures dealing with such issues as catalytic wood stoves, certified wood stoves, and sizing wood stoves (46, 47, and 48). The U.S. EPA has an excellent brochure, *Buying an EPA-Certified Wood Stove*, that lays out specific guidelines on how to estimate the appropriate wood stove according to particular geographical and household requirements (52). In contrast to the specialized approach, Washington's *Wood Heat, Wood Smoke and You* (53) and Montana's *Wood Heat* (45) are quite comprehensive, discussing different facets of wood heating.

The value of any brochure, regardless of how well designed and written it is, depends on getting it into the hands of the wood-burning public. Some areas distribute their material through mass mailings (in addition to its own mass mailing, the Washington Energy Extension office provides brochures to organizations that prepare their own mailings). Also, every agency interviewed that has some form of printed material makes the pamphlet/brochure available on request. Several communities reported that they have a distribution system that includes brochures along with monthly utility bills. The Montana Power Company also includes in its monthly gas bills a brochure about the rebate program the gas company offers for switching from wood to gas heat.

Reproduced from best available copy.

WOOD
WOOD HEATING AND AIR POLLUTION
CERTIFIED WOOD STOVES
Approved by Oregon DEQ
CERTIFIED
WOOD STOVES
WASHINGTON'S Model CLEAN AIR COMMUNITY
Cleaner
WOOD HEAT, WOOD SMOKE AND YOU
A Guide to Wood Heating Decision Making into the 1980's
LET'S CLEAR THE AIR!
GREEN YELLOW RED
A WOOD BURNING WATCH PROGRAM

Figure 2-1. Some representative brochures discussing a variety of RWC devices.

Perhaps the most potent way of distributing PA material is to mail it with notices of ordinance violations. This approach has the advantage of reaching a select segment of the public that could benefit by appropriate educational material. Receiving wood smoke information along with an official citation: (1) reinforces the connection between poor wood-heating practices/ inferior wood-burning appliances and diminished air quality, and (2) serves as a verifiable record that a violator is aware of the ordinance and public responsibility.

2.4 PROGRAM EFFECTIVENESS

Arriving at an evaluation of the actual effectiveness of PA program elements is difficult given the basic mechanics of how PA program elements operate. Short of taking exhaustive personal surveys that ask explicitly if owners of RWC devices reduced their appliance use or altered wood-burning habits directly because of what they had learned through community PA program elements, there is no direct, quantifiable correlation between PA and improved emission levels. However, despite these obstacles, there is a consensus that PA program elements are pivotal to the success and acceptance of a community's overall RWC emission control program. In summary, the PA program element is a necessary -- but often insufficient -- ingredient in a community's comprehensive approach to PM-10 attainment.

Following is an attempt to characterize three levels of effort for a stand-alone (i.e., not combined with other program elements) PA program element. Table 2-3 describes each of the three hypothetical levels of efforts in terms of communication media and level of intensity (or frequency). It must be emphasized that these are presented for illustrative purposes only. The design of a specific PA program element must take into account attitudes, resources, demographics, and other site-specific factors.

Unlike the other program elements described in this document, EPA has decided not to award emission credits for public awareness program elements. Instead, PA is viewed as a necessary component for the success of other

TABLE 2-3. THREE LEVELS FOR HYPOTHETICAL PUBLIC AWARENESS PROGRAM ELEMENTS

Program Level	Media	Assumptions and Intensity
I.	● Broadcast only	● Several PSAs per week on at least one TV station ● Several PSAs per week on at least one radio station
II.	● Broadcast plus ● Public Contact	(Same as Level I above) Three of the following: ● civic groups ● town or neighborhood meetings ● public/private school assemblies ● stove fairs ● formal adult education curricula
III.	● Broadcast and ● Public Contact	(Same as Level I above) (Same as Level II above)
	plus ● Print Media,	At least one of the following: ● At least one paid ad per week in widest read newspaper in the area ● One brochure (printed in volumes equal to one per RWC device in the area). Brochure should cover at least three of the following: -- Health effects of RWC emissions -- Selection of RWC device -- Operation and maintenance -- Fuel selection and use -- Nonhealth benefits of RWC emission control
	plus ● Other	At least one of the following measures: ● One billboard with an RWC emission control theme or ● Prominent sign that has RWC emission control theme in each motel/hotel room with RWC device

program elements. The reasons for not awarding credits for PA are: its effectiveness is virtually impossible to quantify; it is an unenforceable measure; and no standard PA program element can be defined (i.e., it must reflect site-specific circumstances). The PA program element is considered by EPA to be a necessary component for any RWC emission control program seeking SIP emission reduction credits.

2.4.1 Minimal Level of Effort -- Use of One Medium Only

Reliance on any one broadcast medium will be the weakest approach, whereas a comprehensive mix of print, broadcast, and public contact media would yield the best results. Of the three media discussed, TV and radio (i.e., broadcast) alone would likely be the least effective at achieving PA goals. A consensus seems to say that this medium's primary advantage lies in alerting people to current air quality conditions for purposes of curtailment, although there is probably a long-term cumulative effect on the wood-burning public from repeated warnings and alerts.

2.4.2 Medium Level of Effort -- Broadcast Plus Public Contact

A medium level of effort of a PA program element would combine the broadcast and public contact media. A community could initiate its PM-10 program process through a PA program element that focuses first on at least three methods of public contact: (1) town or neighborhood meetings, (2) talks with civic groups (e.g., Kiwanis or Rotary Clubs), and (3) trade shows. Regulatory agency officials and health experts would discuss the ordinance as a whole, then emphasize those health effects of wood smoke that have the greatest psychological impact on the audience. Once all segments of the community have had a chance to attend the public forums, the program element would then rely on regularly scheduled, weekly TV and radio PSAs that act as periodic reminders of the PM-10 program, as well as giving curtailment notification.

2.4.3 High Level of Effort - Multimedia/Extensive Effort

A third, more powerful PA program element would establish a comprehensive network of print, broadcast, and public contact/public education media, in which each approach is coordinated with and reinforces the other two. Public education through workshops, seminars; trade fairs, and community/public schools would be augmented by an extensive range of printed material distributed at each education event. Brochures (printed in volumes equal to one brochure for every RWC device in the area) should cover a range of topics, including:

- Health effects of RWC emissions;
- Selection, operation, and maintenance of RWC devices;
- Fuel selection and use;
- Nonhealth benefits of RWC emission control; and
- Alternative fuel/heating options.

As Washington State and Klamath County have demonstrated, an aggressive public education plan that pairs printed messages with hands-on involvement forms a robust PA program element in which various agencies can continue to address PM-10-related issues (health, quality of life, etc.). Furthermore, printed material such as billboards, bumper stickers, and room signs in resorts that offer RWC devices should also be a part of this program element.

As reported by Maykut, enlisting the support of the broadcast and newspaper media early in the PA process helped ensure popular support for the PM-10 program goals (16). Developing wood heating-related TV and radio programs that go beyond simple PSAs, as well as regular newspaper articles with in-depth coverage of relevant topics, is ideal for large metropolitan areas. And because of the large number of potential and actual RWC appliances in the cities, communities could adopt the system used by the State of Washington, which assesses a $5 tax on all stove sales to subsidize the cost of education. Wherever there is a large number or concentration of wood stove users, novel approaches to print communication (billboards, placemats, bumper stickers, hotel room notices) can also be effective at educating the wood-burning population.

The most effective approach to PA program elements emerges as a broad-based, comprehensive use of public speakers, all types of printed material, and well-timed, highly visible broadcast efforts. What is essential for each regulatory agency is to understand what program elements are best suited to the unique complexion of the community. Changing individual habits of wood burning through an enlightened, aware public is the essence of successful and long-term reductions in PM-10 levels. The key program element to achieving high levels of reduction rests on establishing, then maintaining, a flexible and varied PA program element that involves the community and its resources as a whole.

2.5 TRACKING

As noted earlier, it is difficult to quantify the effectiveness of PA as an RWC emission control measure. Consumer behavior may change as a result of economic factors (e.g., perception that alternative heating is much less expensive), lifestyle trends, or the influence of other program elements. There are public relations firms that are skilled in developing surveys that can isolate whether and to what extent various PA measures are influencing the public.

SECTION 3

IMPROVING WOOD BURNING PERFORMANCE

3.1 INTRODUCTION

Improvement in the combustion of wood in residential units can be achieved in one or more of four ways. First, RWC devices can be designed to employ features (e.g., smaller fireboxes) that can reduce the quantity of particles created during the actual combustion process. Second, the PM-10 produced during combustion can be reduced by installing and operating control devices on the flue gases of RWC devices (such as secondary combustion or catalytic combustion) prior to emission to the atmosphere. Third, requirements concerning proper installation, maintenance, and operation of wood combustion devices can be implemented through a program of education, audits, inspections, and permits. Finally, the types of fuel combusted can be limited to those that are inherently less polluting.

In addition to these four methods of improving wood burning performance, a related approach to reducing emissions of PM-10 would be a program directed at improving the weatherization of homes. This would reduce PM-10 emissions by reducing the amount of wood combusted to heat a residence or building.

A permit program can be included as part of any strategy for improving the emissions performance of RWC devices. A permit program can improve the ability of the control program to reduce RWC emissions and track PM-10 emission reductions. Under a permit program, all owners of new or existing RWC devices would be required to obtain a permit from the state or local air quality agency. From this permit file, the agency could construct and maintain a data base on any increase in the number of RWC devices in the community, which residences have RWC devices installed, and what types of devices are operating in the community. Consequently, a permit program would provide an agency with a method for controlling emissions. A permit program can help ensure compliance with requirements that certain RWC technologies are used, that specified installation procedures are followed, or that fuel quality requirements are followed.

In considering the emission reductions achievable through improving the performance of RWC devices, it should be recognized that these improvements may prove inadequate to remedy a community's PM-10 attainment problems. In these and other instances, program design should emphasize the benefits of encouraging or requiring operators of RWC devices to switch to other, less polluting fuels for residential heating. Program elements prohibiting the operation of RWC devices are discussed in Section 4.3 below.

3.2 CERTIFICATION PROGRAM

3.2.1 Introduction

Certification programs improve the emissions performance of RWC devices by establishing uniform procedures for determining the relative emissions potential of various designs, and by allowing regulators and consumers to distinguish between low-emitting and high-emitting RWC devices. A typical certification program consists of two primary parts. First, a regulatory authority develops laboratory procedures for testing RWC devices to determine their PM-10 emissions characteristics under representative operating conditions. Manufacturers are then required to submit their products, or individual RWC devices representative of their products (i.e., prototypes), for testing to determine their potential emission rates.

Second, the regulatory authority establishes a level of emissions that cannot be exceeded for any device. This prohibition could extend to any RWC device sold within the jurisdiction of the authority, to any device installed in that community, and/or to any device operated in the community. Enforcement of this certification requirement is accomplished through audits of manufacturers or retailers, or through in-home inspections.

The EPA currently administers a certification program applicable to new wood heaters as part of the new source performance standards (NSPS) program under the Clean Air Act (See Section 1.2.2.1 of this document). Under this program, detailed procedures and requirements have been established for testing, selling, labeling, and operating wood heaters.

The effectiveness of certification programs in reducing emissions of PM-10 is generally a function of four factors:

- Growth (or decline) projected in the number of operating devices in a baseline year;
- Rate of replacement of existing devices with certified devices;
- The difference in average emissions between baseline and certified devices, which is governed by the emission standards selected; and
- The difference between the performance of RWC devices in laboratory settings versus their performance in actual residential applications.

A certification requirement reduces emissions to the extent that the percentage of certified RWC devices relative to uncertified devices increases in the community. If certified RWC devices replace existing devices, whether because the existing devices have completed their useful lives or because of regulatory requirements to phase out existing devices, current PM-10 emissions will be reduced. If the total number of RWC devices is expected to increase and new devices are required to be certified, future PM-10 emission increases will be reduced, although actual emissions may still increase.

The emission reduction achieved in a given year through a certification program can be measured by the difference between emissions from certified RWC devices compared to the emissions from uncertified devices. In a program where only new devices are required to be certified, the emissions decreases achieved by a certification program are realized incrementally over a 10- to 20-year period as existing devices are retired. If the implementation of the program is accelerated by requiring the replacement of existing devices before their useful life expires, or through more rigorous enforcement of the certification requirement so that noncompliance is reduced, then the reduction in emissions will be realized earlier and the reductions in the first years of the program will be greater.

3.2.2. State Programs

Certification programs can be incorporated into state wood combustion emission control programs in a variety of ways. The first is through development of an independent state-administered certification program. The states of Oregon and Colorado conduct testing and certification programs for RWC devices sold at retail in those states, in addition to the EPA program. The Oregon program was the first certification program adopted, and served as the model for many of the facets of the EPA program. The EPA is not encouraging the development of certification programs by other states, however. Because the EPA program is national in scope and incorporates the most recent information on emission reduction technology, the implementation of additional programs at the state level would be a duplication of effort.

State and local authorities could take steps to enhance the effectiveness of the federal program. The first such step could be the adoption of the EPA certification program as state law. After adoption, the certification requirement could be implemented and enforced by the states without requiring federal action. Currently, EPA plans to conduct a vigorous retail level enforcement program, but, although empowered to do so, it is unlikely the agency will enforce the program at the household level.[1] A related step in state or local enhancement of the EPA certification program is for state authorities to undertake the responsibility for compliance and enforcement activities required by the program. This entails using state personnel to inspect retail outlets to ascertain whether units being offered for sale are certified, and whether retailers are complying with the labeling requirements.

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[1] Although the focus of the NSPS is on certification of wood heater models by manufacturers, there are provisions that affect retailers (e.g., ban on sale of uncertified wood heaters) and wood heater owners and operators (e.g., operation and maintenance according to owners manual).

Washington is an example of a state that has adopted the EPA and Oregon certification programs as part of the state's regulations. The Washington regulations prohibit the advertisement, offer, sale, bargain, exchange, or donation of any new wood stove in Washington unless it has been tested, certified, and labelled in accordance with criteria and procedures specified by the EPA regulations or the Oregon regulations. The regulation also establishes exemptions from the certification requirement, prohibits local authorities from establishing standards that are more stringent than the state standards, establishes labeling requirements and prohibits alteration of labels, and prohibits alteration of RWC devices that have been certified.

Whether the state adopts the certification program or becomes involved in enforcement of the program, the result is a more vigorous program and, consequently, greater compliance with the certification requirements. This greater compliance reduces RWC emissions and ambient PM-10 concentrations by causing the certification program to be implemented more rapidly and more completely, with a greater rate of compliance with the sales and operation requirements of the program.

Other options are also open to state and local authorities that enhance the effectiveness of the EPA certification program. These involve incorporating the certification requirements into other program elements, such as the exemption of certified devices from curtailment requirements or the banning of uncertified devices from new residences. Jackson County, Oregon prohibits installation of an uncertified RWC devices in a residence, in addition to prohibiting the retail sale of uncertified devices. These prohibitions make the installation of uncertified devices from out of state illegal, which can be especially important in border areas, such as Jackson County where residents have ready access to uncertified devices from adjacent states that do not have certification requirements.

The California Air Resources Board (CARB) is considering a State regulation that would address particular problems faced by that State. It would address the potential problem of "dumping" of RWC devices on the market in California that cannot be sold because of RWC regulations in surrounding States and localities (i.e., Oregon and Washoe County, Nevada).

The adoption of a certification program by a state or local community would not result in significantly greater reductions in emissions than will be achieved by the existing EPA certification program. The existing program reflects the level of reduction in emission rates achievable using current RWC emission control technologies. No certification programs, for example, address emissions from fireplaces,[2] which may comprise 50 percent of RWC emissions in areas such as Denver.

Further, certification programs address primarily long-term changes in emissions, since they require a substantial turn-over in the mix of RWC devices in a community before they accomplish significant reductions in ambient PM-10 concentrations.

Although active state participation in implementing and enforcing the federal certification could enhance the Federal Certification Program, it is not anticipated that state or local agencies will adopt these measures. Further, since the federal program will be national in scope, the additional reductions in PM-10 emissions stemming from state participation are expected to be minor. Therefore, no reductions are recognized in this guidance on designing RWC emission control programs, as indicated in Table 3-1.

3.2.3 Ban on Resale or Installation of Used Uncertified Wood Heaters

Most certification programs, including those developed by the EPA and by the states of Oregon and Colorado, apply only to new wood heaters. Used wood heaters can still be sold by individuals without being certified. As a

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[2] Emissions from fireplaces, unlike "air tight" enclosed wood heaters, are not readily controlled by catalytic or noncatalytic controls.

TABLE 3-1. SUMMARY OF EFFECTIVENESS OF PROGRAM ELEMENTS IMPROVING WOOD BURNING PERFORMANCE[1]

Program Element	Effectiveness (%)	RWC Devices Affected Emissions Affected
1. CERTIFICATION		
a. State implementation of NSPS	N/A	States are not expected to adopt this program element at levels that would affect program effectiveness.
b. Ban on resale of uncertified devices	0	No credit recognized because requirement is largely unenforceable; other elements will be required to include disabling of retired used devices.
2. INSTALLATION QUALITY ASSURANCE		
Installer Training/ Certification or Inspection Program	≤ 5	Reduction in emissions from each new certified RWC device where either the installer is trained/certified or the installation is inspected.

(Continued)

TABLE 3-1. (Continued)

Program Element	Effectiveness (%)	RWC Devices Affected Emissions Affected
3. TECHNOLOGY REQUIREMENTS		
a. Pellet stoves	90	Reduction in emissions from each new or existing conventional, uncertified RWC device replaced with a pellet stove.
	75	Reduction in emissions from each new or existing Phase II EPA certified RWC device replaced with a pellet stove.
b. EPA Phase II certified RWC devices	(Approximately 50)[2]	Reduction in emissions from each new or existing conventional, uncertified RWC device replaced with an EPA Phase II certified RWC device.
c. Retrofit requirement	≤5	Reduction in emissions from each existing conventional, uncertified RWC device equipped with a retrofit catalyst or pellet hopper (to maximum when all existing uncertified RWC devices have retrofit devices installed).
d. Accelerated changeover requirement/inducement	(Approximately 50)[2]	Reduction in emissions for each existing conventional, uncertified RWC device replaced by Phase II certified device.
	100	Reduction in emissions for each existing conventional, uncertified RWC device removed and not replaced; requires existing device to be disabled and not resold.

(Continued)

TABLE 3-1. (Continued)

Program Element	Effectiveness (%)	RWC Devices Affected Emissions Affected
4. FUEL QUALITY REQUIREMENTS		
a. Wood moisture content regulations	≤5	Reduction in total emissions from all RWC devices in the community/airshed.
b. Trash burning prohibition	0	No credit recognized for eliminating trash burning in RWC devices.
5. REDUCTION IN FUEL USE		
a. Weatherization of residences	≤5	Reduction in total emissions from all RWC devices in the community/airshed.
6. OPACITY LIMITS	≤5	Reduction in total emissions from all RWC devices in the community/airshed.

[1] Note: See discussion on credit derivation in Section 1.4.1 and specific discussions for each element before using these values.

[2] Effectiveness depends on replacement device. See Appendix A to obtain emission factors, wood burn rate adjustments (e.g., EPA Phase II stoves are more efficient than conventional stoves) and performance degradation discussion (i.e., the SIP must provide for deterioration in performance). The numbers in parentheses are nominal values appropriate for first cut estimates. They assume a mix of appliances, degradation of performance of catalytic stoves, and that NSPS stoves burn wood more efficiently than do conventional stoves.

consequence, uncertified wood heaters can stay in commerce and continue in use. A ban on the sale or installation of used, uncertified wood heaters would eliminate these wood heaters from the market. Any consumers desiring to install an RWC device in a residence would be forced to purchase new, certified RWC devices. This would lead to a faster turnover in the mix of RWC devices in the community, and replacement of existing uncertified devices with new, certified wood heaters.

An example of a ban on the installation of used, uncertified RWC devices is the local program in Jackson County, Oregon. Oregon has a state regulation that makes it illegal to sell an uncertified stove at a retail outlet. Jackson County has adopted a complementary ordinance that prohibits the installation of an uncertified wood stove in a residence. This provision restricts the sale of used RWC devices in the county, as well as the sale or installation of used, uncertified RWC devices from out of state.

In this guidance, no credit is recognized for a ban on the resale of existing uncertified RWC devices. Instead, it is assumed that each program element calling for the replacement of an existing device with a device having lower emissions will contain a prohibition against the resale of the uncertified appliance and that this prohibition can and will be enforced. Consequently, the emission reduction credit is recognized under the other program elements discussed below. In addition, a prohibition against the resale of used RWC devices in an informal market would be difficult to enforce, making the quantification of reductions in PM-10 emissions speculative.

3.3 INSTALLATION QUALITY ASSURANCE

3.3.1 Introduction

Proper installation of RWC devices is necessary in order to achieve the reduction in emissions possible through the application of low emitting technologies, as well as to realize the most efficient operation of the device as a means of space heating. Several aspects of the installation of an RWC device can affect PM-10 emissions. The device selected for use in a residence should be properly sized to accomplish the heating needs of the residence, without being over-sized. Smaller firebox sizes tend to result in hotter fires, and, therefore, more complete combustion (32). The heating needs of the residents and the structure should be examined so that the device is adequate in size, but not inefficiently large.

Similarly, RWC devices that incorporate thermostatic control devices should not allow severe air supply cycling such that sufficient oxygen for complete combustion is unavailable. The flue gas ventilation system also requires attention. Improperly vented RWC devices result in inadequate intake of air into the unit, adversely affecting the combustion efficiency of the device and increasing emissions. Therefore, the installation of a device should be planned to provide for adequately-sized flue pipes that are designed to provide the most efficient air flow through the device. In addition, the design and installation of flue vents can also aid in reducing ambient concentrations of wood smoke by preventing the downwash of the particulate-laden flue gases.

3.3.2 Installer Training and Certification

An installation training and certification program improves RWC device installation and reduces emissions by improving the knowledge of the retailers, chimney sweeps, and others who are involved in the business of installing wood heaters or constructing fireplaces. This program can be either voluntary or mandatory. A voluntary program offers a course in RWC device installation and fireplace design. Individuals and businesses participating in the program are then able to advertise their certification status. Purchasers of RWC devices can choose certified installers on the assumption that installation by a certified installer results in more efficient, less polluting, and safer operation of the device. In a voluntary program, effectiveness is a function of the degree to which installers and purchasers can be convinced that certification provides benefits to the individual homeowner and to the community.

A mandatory program requires any individual installing an RWC device to be certified. This program differs from the voluntary installer certification program because it affects all new installations and installers, not just those who choose to avail themselves of the program. Consequently, where the voluntary program might reach only a certain percentage of the RWC devices installed, the mandatory program would affect all new installations.

No mandatory installer certification programs have been identified, although voluntary education programs for installers are in operation. Washington state promotes better operation and installation through classes offered to homeowners under its public awareness program, as well as classes that are available to manufacturers, retailers, and operators. The goals of this program are to promote better installation of RWC devices and to increase the retrofitting of catalysts to existing RWC devices.

The effectiveness of a voluntary installer certification program depends on the ability of the air quality authority to convince installers to participate in the program, the ability of certified installers to convince the public of the advantages of certified installation, the degree of improvement in actual installations accomplished through a certification program, and the emissions reductions achieved for individual devices through improved installation. The effectiveness of mandatory installer certification programs depends only on the degree of improvement in actual installations accomplished through a certification program, and the emissions reductions achieved for individual devices through improved installation. An additional factor is whether homeowners installing devices in their own residences would be exempted.

3.3.3 Inspections

Through an inspection program, an air quality agency ensures that RWC devices are properly installed by inspecting residences where new devices or fireplaces are installed. These inspections would ascertain that flue systems, thermostatic controls, and catalysts are properly installed to achieve emission reductions, as well as efficient and safe operation. These inspections could be carried out by the city or county building inspection staff as part of an existing building permit and inspection system. Any such program would be mandatory for new RWC device installations, and could be required for existing RWC devices as well.

There are currently no inspection programs applicable to RWC devices that inspect for factors related to emissions. There are locations, such as Washington State, where inspections are made as part of a building inspection program, particularly for fireplaces. These inspections focus on safety and structural soundness, however, and apply primarily in instances where installation of a RWC device is part of new construction or the remodeling of a residence.

3.3.4 Installation Credits

The effectiveness of installation quality assurance programs is generally a function of two factors. The first is the degree to which such a program accomplishes an actual change in the installation practices of RWC device owners, retailers, chimney sweeps, and others who may install them. The second is the incremental difference in emissions from a device that is properly installed from one that is improperly installed. Both of these factors may exhibit a range in the difference they make in emissions, depending largely on the degree of improvement possible in the installation of RWC devices in a community.

There are little data on which to base credits for improved installation. The technical review group determined that, since the emission factors are based on average-or-better installations, the improvement in installations would result in only a marginal improvement in emissions. Therefore, the credit for measures to improve installation is generally expected to be ≤ 5 percent applied to new installations where either the installer is trained/certified or the installation is inspected.

Since the emission factors in AP-42 (see Table A-4) are based on stoves that were generally properly installed, any large credit for programs to improve installation quality could not be given unless the agency documents that installation quality is poor at a high percentage of new installations. In such cases, the emission factors should be adjusted to reflect the worse-than-average installation.

3.4 TECHNOLOGY REQUIREMENTS

3.4.1 Introduction

Technology requirements reduce emissions of PM-10 from RWC devices by requiring the incorporation of advanced design and technology that inhibit the formation and emission of PM-10. These requirements may call for the adoption of devices that alter the combustion process, that change fuel use patterns, or that remove particles from flue gases.

Generally, a program element involving technology requirements includes a direct requirement that any new RWC device installed in a community must incorporate advanced technology to reduce emissions. In a more stringent program, this requirement might also be applied to existing devices, requiring homeowners to replace existing devices or to retrofit them with catalysts or other control devices.

3.4.2 Pellet RWC Devices

A requirement that only certified pellet stoves be permitted for new installations of RWC devices lowers emissions because pellet stoves have inherently lower emissions than other RWC devices. In more stringent programs, RWC device owners can be required to substitute pellet stoves for existing RWC devices to achieve immediate reductions in emissions.

Pellet stoves require specially manufactured wood pellets and are dependent upon electricity to power the fuel feed system and combustion air. These factors place limits on the applicability of pellet stoves. The special fuel requirements mean that pellet stoves are only feasible where facilities for manufacturing wood pellets are located in the vicinity to reduce transportation costs. The forced combustion air design of pellet stoves has also limited the effectiveness of this technology at high altitudes. In these locations, the fan systems may not provide adequate oxygen for efficient combustion. Finally, pellet stoves are more expensive than other RWC devices, which limits their attractiveness relative to other types of RWC devices and other heating fuels.

Although there are no existing programs that require installation of pellet stoves in either new or existing installations, there are program elements that indirectly promote pellet stove use. The Lewis and Clark County, Montana, program exempts pellet stoves from the local curtailment requirements. Lewis and Clark County also considered requiring pellet stoves to be sold with maintenance contracts to provide for long-term performance, but rejected this proposal because of expected public opposition.

The effectiveness of a pellet stove requirement can be estimated based on the difference in emissions between certified pellet stoves and existing stoves, and the rate of adoption of pellet stoves to replace existing RWC devices. Table A-4 contains the emission factors for the categories of RWC devices. As can be seen from this table, pellet stove PM-10 emissions range from approximately one-fourth the emissions from a catalytic wood heater to approximately one-tenth the emissions of a conventional wood stove.

As indicated in Table 3-1, a program element requiring the installation of pellet stoves would result in significant reductions in PM-10 emissions from wood combustion in a community. For each existing, uncertified RWC device replaced by a pellet stove, the reduction in PM-10 emissions would be 90 percent, based on the difference in emission factors for these types of RWC devices. Similarly, the reduction in PM-10 emissions would be 75 percent for each non-pellet Phase II certified RWC device replaced by a pellet stove. The overall restrictions would be calculated based on the mix of existing devices and the projection of new devices in the community (as determined through the household survey in Appendix A and estimated growth rates).

3.4.3 Phase II Certified RWC Devices

A requirement that all RWC devices be EPA Phase II certified devices is similar to a pellet stove requirement. Phase II devices are designed to achieve more efficient combustion and lower particulate emissions than conventional devices, although their emissions, as shown in Table A-4, are higher than for pellet stoves. Generally, pellet stoves are considered to be a subset of Phase II certified devices.

Requirements that all new RWC devices be Phase II devices have been incorporated into a number of local RWC emission control programs. Telluride, Colorado, and the surrounding San Miguel County incorporate a Phase II device requirement into a permit program for installing and operating a wood stove. To obtain a permit, a device must be among the cleanest on the Colorado certification list. The Telluride program applies to existing devices as well as new ones. Owners of existing RWC devices had 3 years to comply from the adoption of the regulation. Owners of new devices are required to comply immediately. Similarly, Juneau, Alaska, requires a permit for new RWC devices, and qualifying ones must meet EPA Phase II standards for emissions.

The effectiveness of a requirement that Phase II certified devices be installed is projected in Table 3-1. A "first cut" number reflecting the reduction in PM-10 emissions for each existing, uncertified RWC device replaced by a Phase II certified device would be approximately 50 percent, based on the difference in emissions between an NSPS certified device and a conventional device. This assumes a mix of appliances, degradation of performance of catalytic stoves, and that NSPS stoves burn wood more efficiently than do conventional stoves. The overall reductions achievable through this requirement is a function of the number of existing devices replaced (if the requirement is made to apply to existing devices). Since the federal program requires new devices to be certified, this program element would not affect emissions growth from new devices.

3.4.4 Retrofits

Proposals to require that emissions control devices be retrofitted onto existing RWC devices usually specify catalysts or pellet hoppers as the retrofit technologies to be applied to conventional RWC devices. This option has been considered by some communities, but has not yet been adopted into any mandatory residential wood combustion program. Some communities, such as Missoula, have directed at least a part of their public education and awareness activities into encouraging owners of RWC devices to install retrofit catalysts where possible. Retrofit requirements would apply to existing RWC devices and would be most effective if coupled with other requirements, such as a catalyst requirement for new stoves or a ban on new woodburning fireplaces. Since catalysts are generally not designed for use in fireplaces and are unnecessary on existing catalytic stoves or pellet stoves, the reduction would be the extent to which the retrofit requirement reduced emissions from existing conventional stoves.

The effectiveness of a retrofit requirement is a function of the difference between the emissions from the retrofitted devices and the emissions from those devices prior to the application of the technology. It is difficult to derive a general conclusion concerning the effectiveness of a retrofit requirement in reducing PM-10 emissions. Although there are some exceptions, retrofit catalysts and pellet hoppers are not generally designed for a specific model of RWC device. Consequently, the emission reductions achieved by a retrofit technology may vary significantly from one retrofit technology to another, and between applications of a retrofit device to different RWC device designs and models. The Oregon Department of Environmental Quality has estimated, based on laboratory tests of RWC devices equipped with retrofit catalysts, that average emission reductions from these devices was between 42 and 71 percent. Retrofit devices installed in RWC devices in actual residences could be expected to show an even wider range of emissions -- particularly on the low side -- due to variations in installation and operation.

On a community-wide basis, the reduction in emissions achievable through a retrofit requirement depends on the contribution of certified and conventional stoves to the total wood PM-10 emissions, and on the relative number of certified versus conventional stoves being retrofitted. The total reduction in PM-10 emissions could be estimated based on data collected in the household survey, as well as assumptions about emission factors and stove usage patterns. The estimate of a reduction of 5 percent or less in PM-10 emissions described in Table 3-1 is based on the assumption that catalyst retrofits will be required for all uncertified RWC devices in the community, that the requirement will be phased in over 3 years and that quality assurance of the retrofit kit and its installation will be difficult to gauge. This credit could be increased if a method is devised (and approved by EPA) to certify the quality of the retrofit hardware and installation in a particular area.

3.4.5 Accelerated Changeover Requirements

Accelerated changeover requirements lead to faster replacement of existing RWC devices by certified devices. The mechanism for such an accelerated changeover is a direct regulatory requirement, banning certain types of devices or requiring their replacement with approved devices. Instead of basing the replacement rate on the useful life of the device, this program element requires existing devices to be replaced earlier, with the replacement triggered by some change in the status of the device, such as a change in ownership. For instance, in Washoe County, Nevada, installation of an RWC device requires a building permit that cannot be issued unless the permittee has an affidavit of sale that shows that the RWC device meets emission limits of 9 grams per hour for noncatalytic stoves or 4 grams per hour for catalytic stoves. The county maintains a list of devices that meet these limits. The building inspector will not issue a permit unless the device is either exempted from the standard (such as fireplaces, cookstoves, furnaces, etc.) or meets the emission limits (i.e., is on the County's approved list).

The State of Oregon is considering legislation that would require a homeowner selling a residence to upgrade the RWC device in the home to a certified unit (or to remove it entirely). The required upgrade program would foster more widespread use of certified devices and would reduce the number of out-of-state RWC devices brought into the state. In another example, Routt County, Colorado presently requires all existing coal stokers and wood stoves to be changed over to certified Phase II devices or to be replaced with alternative heating (e.g., gas).

An accelerated changeover requirement does not result in a reduction in greater long-term emissions than that achieved by other program elements for improving the emissions performance of wood combustion devices. This program element will, however, result in the benefits of any such program being achieved earlier than would be the case under a "normal" replacement program. A requirement that only EPA Phase II certified RWC devices may be installed in new residences would achieve the same level of effectiveness in reducing emissions, but only over the passage of several years. A requirement that existing devices be replaced by catalytic stoves, or that RWC devices be upgraded on the sale of a home or other event, would quicken the pace of emission reduction.

It should be noted that accelerated changeover requirements may also lead some RWC device owners to switch from wood to other fuels for residential heating. This will result in a greater increase in emissions. Efforts to require or persuade homeowners to adopt a current RWC emission control technology may also "lock in" a technology that may be superseded or improved upon in the near future. This would lead to higher long-term exposure to PM-10 than necessary, and to consumer resistance to any subsequent program element requiring additional or different technologies to meet PM-10 attainment goals.

The effectiveness of an accelerated changeover program would depend on the number and types of devices that would be replaced in each year of the accelerated schedule compared to the number of replacements under a program based on the useful life of existing devices. For each existing uncertified conventional RWC device replaced by a Phase II certified device, the reduction in emissions would be estimated by procedures in Appendix A. This estimate would consider the device mix, adjustments in wood burning rate (i.e. Phase II stoves are more efficient) and performance degradation. A "rough cut" value for use in preliminary estimates would be 35 percent. The estimates of the reduction in PM-10 emissions resulting from the acceleration in the rate of changeover from uncertified to certified RWC devices are contained in Table 3-1.

3.4.6 Accelerated Changeover Inducements

Inducements to accelerate changeovers would be similar to required changeovers, except that the mechanism would be financial or some other form of inducement, rather than the exercise of regulatory authority. For instance, Jackson County, Oregon, has a program for funding the replacement of old uncertified devices in low income housing units with newer, certified wood heaters. A grant of $1.6 million was made available with which the county is hoping to replace RWC devices as well as to provide insulation for 300 to 500 homes at a cost of $3000 to $5000 per dwelling. The program is funded through county funds, rather than private funds.

The effectiveness of the Jackson County program will be measured (when it is completed) by the number of residences that have been provided with certified devices to replace existing ones, and the number of homes weatherized. Currently, the estimate is that 300-500 homes will participate in the program. The important sources of variation in the effectiveness of this program element are the condition of the residences being treated, the willingness of the homeowners to cooperate, and the availability of funding.

Montana also has a program for encouraging the accelerated changeover from older devices to newer, more efficient and less polluting wood combustion devices. Through this program, stove purchasers get a tax credit for buying clean stoves to replace existing stoves. Alaska has approached this same issue by providing a low interest (5%) loan program enabling individuals to purchase qualifying catalytic wood stoves.

The effectiveness of these inducements to accelerated adoption of less polluting technologies is a function of the success of the program in motivating homeowners to invest in the newer technology. A program of grants, such as that in Jackson County, will be most effective, in that it entails virtually no cost to the homeowner. A tax incentive or low interest loan program, on the other hand, will result in fewer owners of existing devices switching to other technologies. It would, however, encourage purchasers of new systems to consider low emitting technologies.

In addition to the effectiveness of the inducements in increasing the level of consideration of lower emitting technologies, the reductions achievable are also dependent on the difference between the technologies being encouraged and those currently in use. In this context, it should be noted that programs providing incentives to change over to cleaner RWC devices may have the unwanted effect of accelerating new RWC device sales (as opposed to sales of heating devices using cleaner alternative fuels, such as natural gas), resulting in a diminishment in the effectiveness of the incentives in reducing pollution. Additionally, as with accelerated changeover requirements, the effect is to change the timing of the emission reductions, not to change the magnitude of the reductions ultimately achieved.

The decrease in emissions of PM-10 resulting from the adoption of an incentive program is described in Table 3-1. As with changeover requirements, the reductions for replacement of an existing, uncertified RWC device by a Phase II certified device would be estimated by procedures in Appendix A. This estimate would consider the device mix, adjustments in wood burning rate (i.e. Phase II stoves are more efficient) and performance degradation. A "rough cut" value for use in preliminary estimates would be 35 percent.

3.5 FUEL QUALITY REQUIREMENTS

3.5.1 Introduction

Certain fuels inherently produce more PM-10 when burned in an RWC device than other fuels. The major characteristics of fuels that contribute to the formation of PM-10 are ash content and moisture content. Coal, for instance, has a high ash content relative to wood. Therefore, some communities, such as Lewis and Clark County, Montana, prohibit the burning of coal. (In that county, users of coal who can show that they burned coal prior to 1981 are exempted from the ban.) For wood, the most important fuel characteristic contributing to variations in PM-10 emissions is fuel moisture. It must be recognized that enforcement of these programs may be difficult.

3.5.2 Wood Moisture Content Regulations

Regulations that restrict the fuel moisture content of wood require wood burned in RWC devices to be dried and cured to reduce the moisture content. These restrictions can be applied either to wood offered for sale, or to all wood burned in the community.

The Jackson County, Oregon, RWC emission control program provides wood moisture measurement services to RWC device owners. Jackson County's public awareness campaign is directed at urging wood burners to use only well-seasoned wood. In conjunction with this effort, the county has installed instruments for measuring wood moisture content in firehouses around the county, where individuals can have the moisture content of their fuel wood measured for free. The county recommends a 6 to 12 percent moisture range.

Telluride, Colorado, has an ordinance that requires firewood be covered to promote drier wood and, therefore, more efficient and cleaner burning. It also requires that wood be seasoned and that only wood, not trash or other materials, be burned. Although uncovered stacks can be identified for enforcement purposes, the requirement for seasoned wood be burned in RWC devices is not readily enforceable.

Washington also has a requirement that wood be well-seasoned (no more than 20 percent moisture content), but the program is largely unenforceable because of the difficulty of obtaining access to wood piles to inspect for moisture content, particularly in a state where many RWC device owners cut their own wood.

The effectiveness of a fuel moisture content requirement is measured by the difference between the emissions from the combustion of poorly seasoned wood and properly seasoned wood. This theoretical difference must be tempered, however, by recognition that the enforceability of any such requirement will be limited. Under these conditions, a public awareness program, such as that in Jackson County, may be as effective as a regulatory requirement. The incentive to burn dry, well-seasoned wood can be heightened when the public understands that burning moist wood results in reduced heating performance.

The estimate of emission reductions achievable through wood moisture regulations is described in Table 3-1. Because of geographic and seasonal variability in wood moisture and the difficulty in enforcing a wood moisture regulation, only minimal reduction credits are recognized. Further, because pellet fuels do not vary significantly in moisture content, a wood moisture regulation would accomplish a lower percentage reduction in emissions if the number of pellet stores increases.

A specific program to address wood moisture might justify higher credit if it can be shown that the burning of unseasoned or wet wood is particularly prevalent in that area and that the program is both effective and enforceable. Several additional program features can be considered in addition to those discussed above. These include the establishment of community-run wood banks, where green wood is exchanged for seasoned wood, with or without a nominal fee. Also, programs to license wood sellers or restrict the cutting of green wood during or just prior to the heating season may be considered. Any wood moisture program should address public awareness, as discussed above.

3.5.3 Trash Burning Prohibition

A number of communities prohibit trash burning as a measure to control PM-10 emissions from residential heating. Because of the variable make up of trash fuels, as well as the potential for emissions of potentially toxic materials from the combustion of plastics and other substances, restrictions on burning trash in heating devices typically address problems with odors, noxious gases, and toxic pollutant emissions.

Washington State prohibits the burning of waste products, liquid fuels and/or treated or painted woods. Although the ban on what types of wood may be burned is mandatory, this is the weakest element of the state's program because it is difficult to inspect what homeowners are actually burning.

Lewis and Clark County, Montana, has a prohibition against the burning of any solid fuel except newspapers, untreated kraft paper, untreated wood and lumber, and products made specifically as wood for wood stoves. Telluride, Colorado, and Washoe County, Nevada, have similar requirements. All of these prohibitions are difficult to enforce.

The PM-10 emissions reduction achievable through a ban on burning trash is difficult to estimate. This difficulty is made greater by the fact that particulate matter from trash burning has proportionately less PM-10 than particulate matter emitted from wood burning, so that PM-10 emission levels cannot be assumed from total particulate emissions. Further, any ban on burning trash in residential combustion devices would be difficult to enforce. Therefore, although elimination of trash burning may reduce PM-10 emissions, it is not anticipated that any such requirement would accomplish significant reductions. Consequently, no emission reduction credits are recognized for this program element. Restrictions on trash burning might be achieved through a public awareness campaign that would emphasize the potential toxic emissions from burning trash.

3.6 Weatherization

In addition to employing technology to reduce PM-10 emissions by reducing particulate formation during combustion or removing particles from flue gases, emissions can also be reduced by reducing the amount of fuel combusted in a wood combustion device. Weatherization reduces fuel use by reducing the heating requirements for the residence. The addition of insulation, weather-stripping, and other means of insulating the interior of the residence from exterior cold reduces the amount of space heat required to maintain indoor temperatures at a comfortable level.

Jackson County, Oregon, has a program of grants to homes in low income areas to subsidize weatherization. A similar program is also used in Klamath County. The shortcoming of these programs is that they are only applicable in low income areas, not middle class areas.

Another shortcoming of weatherization efforts is the potential to exacerbate indoor air quality problems in the residence. If a house is weatherized to the point that ventilation is overly restricted, the residents may be subject to chronic exposures to indoor pollutants (from dry cleaning fluids, building and insulation materials, cigarette smoke, and other materials). However, programs which address the R-value of insulation do not exacerbate indoor air quality problems. In general, a low credit (<5 percent) is expected for weatherization programs because the percentage of homes in a particular community that would benefit substantially from improved R-value is likely to be small. A thorough engineering analysis of the decrease in wood consumption attributable to improved home insulation in a particular community could justify a higher credit.

3.7 Opacity Limits

Limitations on the opacity of emissions exiting a stack are a regular feature of regulations limiting particulate matter emissions from industrial sources. These opacity limits serve two purposes. First, they are measurable indicators of particulate matter emissions that can be used by an air quality agency to determine the occurrence of violations of an emission standard or permit limit. Second, high opacity levels indicate when there may be a malfunction or problem with the operation of a source that requires repair or remedy.

In order to implement an opacity limit for RWC devices, it is necessary that the enforcement personnel for the air quality agency be trained to make visual opacity readings. When properly trained, an individual is able to distinguish between various percentages of opacity with accuracy and predictability. In addition to being trained in opacity reading, however, these individuals must also be trained to make these readings at night. Night time emissions are important in controlling RWC emissions because RWC devices are typically operated at the highest burn rate early in the evening, then late at night are operated under very low air conditions to burn through the night. Both of these operating practices can create worst-case PM-10 emissions problems.

Several localities include opacity limits in their RWC emission control programs. Juneau, Alaska, included an opacity limit in their early regulations addressing RWC emissions. The opacity standard allowed agency staff to identify those RWC device owners who were out of compliance with the opacity limit and to discuss proper device operation and maintenance to reduce stack emissions. This approach was labor-intensive in the initial two heating seasons, but worked to reduce the enforcement effort required later in the development of Juneau's RWC emission control program.

Enforcing opacity limits requires substantial commitment of personnel. Although the use of air quality officers for this purpose may be the desired approach, budgetary limits may require the use of other personnel. Juneau initially assigned animal control officers to enforce opacity regulations, and trained them in opacity (smoke) reading. Subsequently, this was delegated to the police department. Although using the police force increased the capability to observe violations or handle complaints, RWC emission enforcement was given a lower priority than other police work.

An opacity program could be used to ensure that certified stoves are properly installed and maintained. Thus, an opacity regulation could be valuable in ensuring that stove installation is properly accomplished and that the stove is continuing to operate as designed. However, there are significant limitations to an opacity program: (1) the budget and personnel problems cited above; (2) the lack of conclusive data on opacity limit effectiveness; (3) the fact that many appliances would operate within reasonable limits; and (4) a start-up or refueling exemption would make enforcement cumbersome. Thus, a credit of ≤ 5 percent is given unless a strong case can be made that these limitations do not apply or can be overcome in a particular community.

SECTION 4

REDUCING USE OF RWC DEVICES IN A COMMUNITY

Limiting the use of RWC devices in a community through the use of alternative fuels reduces ambient levels of PM-10 by reducing the amount of wood combusted for space heating. By focusing on reducing the use of RWC devices, residents turn to alternative fuels, such as natural gas or electricity. These alternative fuels produce lower PM-10 emissions for the amount of heating value they provide. Therefore, to the extent that less wood is combusted for residential heat and more reliance is placed on these other fuels, local PM-10 problems could be avoided or alleviated.

There are three types of program elements that can be designed to achieve a restriction or reduction in the number of RWC devices in a community. The first focuses on making fuels other than wood more available and more attractive as alternatives to wood for residential heating. In some communities, merely making alternative fuels, such as natural gas, more available for residential heating could lead residents to switch from wood and reduce PM-10 emissions as a consequence. In other circumstances, the use of alternative fuels for residential heating can be promoted by the local air quality agency through various economic incentives, increasing the use of lower-emitting fuels and reducing the amount of wood combusted.

The second group of program elements would be directed at restricting growth in the use of wood as a residential heating fuel by restricting the use of RWC devices in new or existing residences. This restriction could take one or more of several forms. One approach would be a requirement that existing RWC devices must be retired before new devices are allowed to be installed, so that the emissions from new RWC devices are offset by reductions from retired devices. Another approach would provide economic disincentives to the use of wood as a residential heating fuel through the use of taxes on new RWC devices. The most stringent restriction on new RWC devices would either ban new RWC devices altogether, or limit on the number of devices allowed to be installed in a residence.

Under a program restricting new RWC devices, residents would have to adopt other technologies and other fuels for space heating. Restrictions applicable to new residences would slow the growth in PM-10 emissions from new RWC devices. Current PM-10 emission levels would not be directly affected, but would be reduced over the longer term as existing RWC devices are retired and replaced by other heat sources.

The third group of program elements would be directed at the elimination of both new and existing RWC devices from the community. The number of existing RWC devices could be reduced through the use of economic incentives and disincentives aimed at influencing residents to adopt other technologies and fuels for providing residential heat, or through the use of regulatory actions against the use of wood as a heating fuel. These measures would either mandate conversion of existing residences from wood to other fuels, or would provide incentives designed to lead to this conversion.

These three approaches to limiting or eliminating the use of RWC devices for residential heating are discussed in greater detail below.

A permit program would be a valuable part of an RWC control program based on limiting the population of RWC devices in a community. First, the permit program would enable the air quality agency to determine the existing population of devices at the beginning of the emission control program so that the effectiveness of control measures could be evaluated. Second, withdrawing permits for individual RWC devices can be a practical way of tracking which residences have replaced wood as a residential heating fuel with heating systems using fuels other than wood. Third, RWC permit requirements for new and existing dwellings could facilitate the administration of emission offsets, as well as taxes or restrictions on the installation of RWC devices in new dwellings. Finally, permits can be an effective way of implementing an incentive program for the elimination of RWC devices from existing residences.

4.1 BACKUP HEAT OR ALTERNATIVE ENERGY SOURCES

4.1.1 General

Except, perhaps, for the most isolated residences, there are alternative fuels available for residential heating. Electricity, propane, solar, and oil are widely available for residential heating, and natural gas is available in many areas. Although the particulate matter emissions from the use of these fuels varies, they all emit much less particulate matter than wood combustion. There are no emissions of particulate matter from solar heating or various other alternatives to combustion, such as the use of geothermal sources of heat. Particulate matter emissions from oil, propane, and natural gas combustion are negligible. Even the particulate matter emissions from the combustion of coal are less than one-fourth the emissions from wood combustion on a gram PM-10 per kilogram fuel combusted basis.

4.1.2 Facilitating Availability of Alternative Fuels

Natural gas is the primary alternative to the combustion of wood as a residential heating fuel in terms of emissions, convenience, and cost. Electricity and oil are also preferable heating fuels compared to wood, but are typically more expensive and less efficient than natural gas. There are several types of heating appliances available on the market that could compete with RWC devices for cost, convenience, and reliability. The most common natural gas-burning appliance that replaces wood combustion for residential heat is the gas fireplace or "gas logs." Newer models of these fireplaces combine combustion efficiency with some of the aesthetic attractions of wood-burning fireplaces. In addition to gas fireplaces, manufacturers are also starting to produce gas-fired heaters that look like wood stoves, as well as kits for converting an existing wood stove for natural gas combustion. When designed or converted for natural gas, these devices cannot be used to combust wood.

The basic limitations to the use of natural gas as a residential fuel, however, are availability and the cost of making natural gas available. Natural gas is only available to homeowners where pipelines and service lines have been constructed to bring this fuel to the community. Therefore, one of the elements that could be adopted into an RWC emissions control program is making natural gas services available in communities and in neighborhoods where it cannot now be obtained.

As part of its overall program for controlling wood combustion emissions, Telluride, Colorado, encouraged a natural gas supply and distribution company to bring natural gas into the town. Partly as a result of this program element, Telluride has experienced a significant shift from the use of RWC devices to gas logs as a source of residential heat. The growing residential community in Telluride, coupled with the town's other programs restricting wood combustion as a source of residential heat, made this community attractive to the natural gas company. In other circumstances, other incentives to the introduction of natural gas might have to be supplied, such as favorable price and right of way considerations, or an agreement to purchase natural gas for public buildings and services.

In addition to making natural gas more available as an alternative fuel for heating residences, local authorities can also make other fuels or alternatives to wood heat available. Favorable electric rates and oil prices can be negotiated with suppliers so that these residential heat sources are more available and more economical.

Making an alternative fuel more available will not result in greater adoption of that fuel or reduced combustion of wood unless the alternative is more attractive in terms of cost, convenience, or reliability. The effectiveness of this program element in reducing particulate matter emissions from wood combustion rests on changing the perception of wood as a heating fuel compared to natural gas, electricity, or other heat sources. Consequently, local authorities considering the adoption of this program element should ascertain whether wood is either more expensive, more difficult to get, or less reliable than alternative fuels. A first step in formulating a program to persuade RWC device owners and owners of new dwellings to choose alternative residential heating fuels would be to determine and publicize the "true" cost of wood, including:

- The cost of an RWC device,
- The cost of the wood itself on a dollars per Btu basis,
- The cost of cutting and transporting wood,
- The time involved in splitting, storing, and using wood, and
- The time and inconvenience involved in disposing of ashes.

If existing economic considerations do not make natural gas, electricity, or other fuels attractive and lead to the adoption of those fuels in preference to wood, the local authority can also alter the context of this decision through the exercise of regulatory authority. Telluride has done this by passing a prohibition on fireplaces and certain types of wood heaters. In another approach, the local authority can also change the economic context of the decision by offering incentives for homeowners to adopt alternative fuels, as discussed in the following part of this section. In either case, it is important to note that making alternative fuels more available should generally be seen as part of a program that includes other elements that influence the selection of fuels other than wood.

There has been little research conducted that would indicate the level of reduction in PM-10 emissions that could be achieved through making alternative heating fuels more readily available. Such effectiveness would, as discussed above, depend on a variety of other factors in the decision making process.

In estimating the effectiveness of a program to make natural gas (or other alternative fuels) more available, the air quality agency must project the number of RWC devices that would be replaced by heating devices using other fuels, and the extent to which the continued use of RWC would be for supplemental heat or aesthetic purposes, rather than as a primary heat source. In projecting PM-10 emission reductions for the purpose of evaluating SIP regulations, credit can only be recognized for those program elements that can be assured of achieving permanent and enforceable reductions. Consequently, no credit for emission reductions can be recognized in instances where an RWC device is retained, even though an alternative fuel is incorporated into the residential heating system.

The mix of RWC devices that would be replaced if alternative fuels are made available - that is, the number of conventional, certified devices versus the number of Phase II certified devices - would have to be projected by the agency to determine the quantity of emissions reduced. In making this projection, it should be noted that most existing RWC devices replaced could be expected to be conventional, uncertified devices that have relatively high PM-10 emissions. For new residences, however, the switch to alternative fuels would reduce the growth in PM-10 emissions from the lower-emitting Phase II certified RWC devices.

The projection of emission reductions from making alternative fuels more available should reflect the expectation that most changes from wood to natural gas or other fuels will take place in the first year after other fuels are made available. After the first year,the effectiveness of this program element would reduce each year. It should be assumed that no more than 10 percent of the residences in the community would switch entirely from wood if alternative fuels were made available for the first time.

Where the RWC device is replaced by the alternative heating system and the RWC device is removed and disabled, credit is recognized for 100 percent of the emissions from all RWC devices removed, as indicated in Table 4-1. This estimate is based on a program that makes alternative fuels more available, without providing additional incentives for switching fuels.

TABLE 4-1. SUMMARY OF EFFECTIVENESS OF PROGRAM ELEMENTS LIMITING POPULATION OF RWC DEVICES[1]

	Program Element	Effectiveness (%)	RWC Devices Affected Emissions Affected
1.	BACKUP OR ALTERNATIVE ENERGY SOURCES		
a.	Availability of alternative fuels	100	• Reduction in emissions from each RWC device removed from service and replaced with device using natural gas; recognize no more than 10 percent of RWC devices replaced under program with no additional incentives.
b.	Economic incentives for fuel switching	Variable	• Emission reduction credit varies with type and size of incentive and the extent to which this incentive results in a reduction in the number or use of RWC devices in the community.
2.	LIMITING NEW RWC DEVICES		
a.	Emission trading requirement	Computation Required	• For a 2:1 trading ratio, the reduction in emissions from each new stove would be calculated as the difference between emissions of a new RWC device and 2 times average emissions per stove in community; multiplier would change for other trading ratios.
b.	Taxes on new RWC devices	Variable	• Emission reduction credit would vary with utility or tax rate structure adopted and extent to which this resulted in reduction in number of RWC devices in the community versus reduction in use of RWC devices.

(Continued)

TABLE 4-1. (Continued)

	Program Element	Effectiveness (%)	RWC Devices Affected Emissions Affected
3.	ELIMINATING EXISTING RWC DEVICES		
a.	Incentives to remove and disable existing RWC devices	Variable	• Emission reduction credit varies with type and size of incentive and the extent to which this incentive results in a reduction in the number or use of RWC devices in the community.
b.	Regulatory prohibition against operation of RWC devices	100	• Reduction in emissions from each RWC device removed.

[1] Note: See discussion on credit derivation in Section 1.4.1 and specific discussions for each element before using these values.

4.1.3 Economic Incentives

The use of economic incentives to encourage homeowners to change from wood to other fuels is the next step after making those fuels available in the community. In this program element, the relative economic attractiveness of wood versus other fuels is changed by initially making the other fuels less costly. Through tax incentives, direct payments, or preferential utility rates (or a combination of all three types of incentives), the community can subsidize lower-emitting fuels, such as natural gas or electricity, making them attractive to more homeowners.

A tax incentive program to encourage fuel switching would give homeowners and builders a reduction in local taxes to offset at least part of the cost of installing a heating system using natural gas or other alternative fuels. This tax reduction could be applied against local property taxes, sales taxes, and/or income taxes. A tax credit would allow a homeowner to reduce taxes by an amount intended to offset the cost of installing and using the alternative fuel. A tax deduction against income tax would allow the homeowner to reduce taxable income to offset the cost of the new heating system. Both approaches to tax incentives would require some form of legislation, usually at the State level.

Direct payments can take two forms. The first is a direct subsidy to the homeowner to offset any increase in costs incurred in changing to an alternative fuel. The second is a payment for switching fuels that is only indirectly tied to the cost of removing an RWC device from a home. Both forms of direct payments require a significant source of funding be made available to the air quality agency.

The town of Telluride, Colorado, provided direct payments as incentives to homeowners to convert from wood combustion to alternative fuels. During the first year of a 3-year grant program, grants of $200 were made available to homeowners to finance the conversion of home heating systems from wood to natural gas or electricity. In the second and third years, this amount was lowered to $150 per residence, and then to $100 per residence. The purpose of this graduated incentive payment program was not only to encourage homeowners to convert from wood heating, but also to encourage them to do so early in the three-year period rather than waiting until just before the deadline. This incentive program was coupled with Telluride's requirement that uncertified wood heaters and fireplaces be removed or dismantled over a 3-year period.

Utility rates can be changed to reduce costs for alternative fuels as an incentive to homeowners to switch to the alternative fuels. The change in the rates would reduce the cost of alternative fuels relative to wood, making the alternative fuels more attractive for home heating. This incentive would require the cooperation of the utility company and would have to be consistent with the utility's revenue requirements

The electric utility in Boise, Idaho, developed an incentive program to encourage homeowners to switch from wood to electricity for residential heat. The goal of this program element was to reduce or eliminate the cost advantage that wood has over electricity in the perception of many homeowners. Under this program element the electric utility in Boise calculates the average monthly use of electricity for the residence prior to the installation and operation of an electric heating system. This baseline electricity requirement is then compared to the monthly electric power demand for the residence following the installation of the electric heating system. The electric utility then reduces by half the cost per kilowatt-hour of electricity for the usage that exceeds the established monthly average.

The design of a program element incorporating economic incentives for homeowners to switch from wood to other fuels for residential heating should begin with an economic analysis of the relative costs of each fuel to the homeowner. This analysis should consider not only the costs of the fuels, but also their cost on a dollar per Btu basis and the cost of the equipment necessary to use a different fuel. From this analysis, the agency should be able to project the number of homeowners who will switch fuels at a given incentive level. Those who are constructing new dwellings may be more amenable to these types of incentives, since they have not already made investments in heating systems. Owners of existing RWC may be more difficult to influence with incentives.

When the level of incentive required to achieve a given level of adoption of alternative fuels is established, the means of making that incentive available should be examined. Tax incentives and direct payments are under the direct influence of the air quality agency and the governmental bodies with which it is associated. Tax incentives are typically longer term programs, where the payment may be spread over several years. Direct payments, on the other hand, would be one-time, lump payments.

Utility rate changes would have to be coordinated between the air quality agency and the local utility company. The utility would have to be persuaded that the loss of revenues involved in offering lower rates to homeowners for switching to natural gas or electricity would be offset by the increased use of those fuels. This would involve an economic analysis of the behavior of homeowners in selecting fuels and of their fuel use patterns over a period that may extend several years.

The effectiveness of these incentive programs is dependent on the level of incentive and the degree to which the incentive alters the economic attractiveness of wood relative to natural gas, electricity, or other fuel. The air quality agency would have to be able to show through an economic analysis the number of existing RWC devices that would be removed and disabled under the incentive program. For new dwellings and new RWC devices, the analysis would have to estimate the difference in the number of RWC devices that would be installed in the community with and without the incentive program. For each RWC device that the agency could show would be removed or not installed, the credit, as shown in Table 4-1, would be 100 percent. No credit is recognized if the installation of a heating system using an alternative fuel only results in a partial reduction in the use of a RWC device for residential heating.

4.2 LIMITING NEW RWC DEVICES

Program elements that limit the growth in the number of RWC devices in the community reduce PM-10 emissions by discouraging or prohibiting the use of wood for residential heating. These elements address the growth in PM-10 emissions from wood combustion that would be expected to take place in a community in the absence of a control program. They would not serve to reduce existing emission levels directly, but as existing RWC devices are retired and replaced with heating systems using other fuels, existing emissions would be reduced.

Three program elements have been identified that address the choice of heating fuel and residential heating appliance for new residences. The first program element addressing emissions from new dwellings is an offset program. This program element would require any additional emissions from an RWC device installed in a new dwelling to be offset by compensating reductions obtained by retiring RWC devices elsewhere in the community. Through this measure, total emission levels in the community can either be held constant, or reduced if the offset ratio is greater than 1-to-1. This program element would also make the use of RWC devices more expensive and make other fuels relatively more attractive.

The second program element applicable to RWC devices on new dwellings is an economic incentive in the form of a tax on new RWC devices. This tax would make RWC devices less economically attractive relative to other technologies and other fuels.

The third and most stringent is a ban on RWC devices in new residences. By requiring builders of new homes to look to other fuels such as natural gas, electricity or oil for space heating, PM-10 emissions from these sources can be virtually eliminated. Further, as existing RWC units are retired, the current PM-10 emission levels can be reduced over time.

Each of these program elements is discussed in more detail below.

4.2.1 Emission Offset Requirement

Under an emission offset requirement, the builder or owner of a new dwelling would have to eliminate an existing RWC device before the air quality agency would permit the installation of a new RWC device. This may mean that the homeowner or builder would eliminate an existing device that the owner or builder already owns, but more frequently would require the purchase of an RWC device from another individual. This may mean negotiating with other homeowners for the purchase and disabling of their wood stoves, or for the dismantling of their fireplaces.

Offset programs can be designed either for the maintenance of existing air quality or for the gradual improvement in air quality. If the owner of a new wood combustion device is only required to find offsetting emission reductions equal to the emissions from the proposed new device, then emission levels would be maintained but not improved. If, on the other hand, the owner of the new device is required to eliminate emissions in an amount greater than the emissions from the new device, then the result would be an overall reduction in total emissions.

Okanogan County, Washington, has an offset program for the Methow Valley area that requires a permit for installation of a wood stove or fireplace in a residence. One requirement for obtaining a permit is that the permit can only be issued if it replaces an existing device in the same residence.

Telluride and surrounding San Miguel County, Colorado, have perhaps the most active offset program in the country. This offset program operates in combination with a permit system. Every new solid fuel heating device being installed in the town requires the elimination of two existing permits. Someone who wants to install a new device in a new or existing structure is required to (1) buy two existing permits, resulting in the elimination of two existing devices, and (2) purchase a stove from Telluride's list of qualifying stoves. The current market price in Telluride for a permit for an existing stove is approximately $1,000, so the offsets for a new stove would cost $2,000.

The effectiveness of an offset program is dependent on the ratio required between the new emissions and the emission reductions required for the offset, and on the rate of installation of devices in new dwellings. The greater the ratio of emission reductions to emission increases required in establishing offsets, the more rapid the decrease in emissions. Similarly, if there is a rapid rate of growth in new dwellings in an area and, as a part of that growth, a large demand for offsets for new RWC devices, the rate of PM-10 emission reductions would be increased.

The effectiveness of the Telluride program can be gauged in part by the reduction from 550 to 400 permitted solid fuel heating units over the past two years. If this entire program were attributable to the offset provisions, this would mean that 150 new units have been permitted in Telluride, but that 300 units were retired as part of the offset program, resulting in a net reduction of 150 units in two years.

The emission credit recognized for an emission offset requirement will vary with the trading ratio. If the trading ratio is 1:1, no credit for PM-10 reductions can be recognized, since there will be no net reduction in the number of RWC devices in the community. If the trading ratio is 2:1, the credit would be calculated as the difference between the emissions from the new RWC device and the emissions from two average RWC devices in the community. This multiplier would vary with the trading ratio.

4.2.2 Taxes on New RWC Devices

Imposing or increasing taxes on new RWC devices might slow the increase in RWC emissions in an area by effectively increasing the cost of wood heat relative to other sources of heat or types of fuel. The intent of the tax should be to give other fuels such a competitive advantage over wood that the owners and builders of new homes will elect to install and use heating systems using other fuels. Taxes on new devices, whether they are installed in new or existing dwellings, would not serve to reduce existing emissions directly, since they would not increase the rate of replacement of existing RWC devices or the reduction in the use of wood as a fuel for space heat.

In addition to a program that taxes all RWC devices, it would also be possible to design a program that would selectively tax certain types of devices. For instance, a tax placed on fireplaces would result in fewer fireplaces being installed in new dwellings if no tax, or a smaller tax, were placed on certified wood stoves. In this case, the tax would result in a change in the types of RWC devices going into new dwellings in the community.

In designing a tax policy to limit the installation of new RWC devices, the air quality agency should consider the applicability of the tax to certified devices that are intended to replace existing uncertified devices. If the tax operates to restrict the purchase of replacement devices in this instance, the retirement of existing devices may be restricted and higher emitting units may be retained in service longer. This would result in a slower decrease in PM-10 emissions than would otherwise be anticipated from the certification program.

In Table 4-1, a PM-10 emission reduction credit is recognized for each new RWC devices that would not be installed as a result of the imposition of a tax on new devices. For each device avoided, the emission credit would be 100 percent. In order to determine the number of RWC devices that would not be installed as a result of setting the tax at a certain level, the air quality agency will have to perform an economic analysis projecting the effect of different tax levels on RWC device purchases.

4.2.3 Ban on RWC Devices

A program incorporating a ban on the installation and operation of wood stoves and/or fireplaces in new dwellings can take several forms. First, the ban can prohibit the installation of all RWC devices, essentially ending the increase in the use of wood as a fuel for space heating in residences in the community. Second, communities could also extend such a ban only to certain types of RWC devices. There are a variety of such programs, ranging from a total ban on the installation of uncertified RWC devices in new dwellings to bans on fireplaces. A third variation on the prohibition of RWC devices from new dwellings limits the number of devices allowed in a residence. Although not a total ban, these provisions accomplish the same basic goal as a total ban by limiting the number of new devices allowed in a community. These restrictions on RWC devices in new dwellings will reduce growth in PM-10 emissions from wood combustion, but would not affect existing emissions in the short term.

San Miguel County, Colorado, is an example of a community that bans a certain type of RWC device. Their program prohibits the installation of wood-burning fireplaces in new dwellings. Mammoth Lakes, California, has a zoning ordinance limiting the number of solid fuel burners per residence to one per residential unit or commercial building and one per single family residential unit. The devices installed under this requirement must be certified. Similarly, the Lake Tahoe Regional Planning Agency has an ordinance that limits the number of stoves to one per house and bans fireplaces in new construction because fireplaces cannot be effectively controlled and therefore are not certified (although they are considering allowing one fireplace in lieu of a stove).

Several ski resort communities in Colorado have also enacted limits on the number of devices that are allowed in new dwellings. In Aspen and Pitkin County, Colorado, new dwellings are limited to one fireplace (with gas logs only) and one certified stove. The Steamboat Springs (Routt County), Colorado ordinance also prohibits more than one device for each new structure, or one solid fuel device per multifamily building.

Banning all or certain types of RWC devices in new dwellings will not, by itself, result in reductions in emissions or ambient concentrations of PM-10 throughout an airshed. A ban that is limited to new dwellings would only lessen the rate of increase in emissions resulting from growth of the community. This effect would be estimated by projecting the number of new RWC devices that would be installed in the absence of the ban and the emissions from those new devices. Emissions from the more limited number of devices installed after implementation of the ban would also be projected. The difference between these emission rates would be the measure of the effectiveness of the ban.

Under a total ban, new PM-10 emissions from wood combustion would be eliminated and there would be no increase in emissions. If the ban only applies to certain types of RWC devices or to reduce the number of devices in a dwelling, emissions would still increase as new dwellings are built. The rate of increase would be lessened, however, because the average emissions per device and/or the number of devices would be lower in dwellings built after the ban.

An example of a ban on installation of certain types of devices is the RWC control program in Washoe County, Nevada. This program includes a specific provision calling for the elimination or replacement of existing devices on resale of a residence. When a residence is sold, any uncertified RWC device must be replaced with one that is certified as complying with Federal standards. Planners have projected a 5 percent reduction in annual emissions of particles from residential wood combustion. Because the turnover rate in home ownership in Washoe County is about 8 percent per year, the county expects that over a 5-year period, about 40 percent of the housing stock will have either removed noncomplying heaters or upgraded to clean burning ones. The assumption is that half of the residential structures will comply with the provision of the ban by eliminating solid fuel burning entirely, and that half will comply by using wood heaters that achieve a 75 percent reduction in particulate matter emissions, compared to conventional uncertified heaters.

In Table 4-1, a PM-10 emission reduction credit of 100 percent is recognized for each RWC device that is not installed in the community as a result of the ban. If the prohibition adopted is against all RWC units, the credit is for all PM-10 emissions that would have taken place in the absence of the control program. If only certain types of RWC devices are banned, the credit extends only to those devices of that type that would have been installed if the ban were not adopted. The credit recognized for a limit on the number of devices permitted in each residence would be based on the number of dwellings with multiple RWC devices avoided as a result of the ban.

4.3 ELIMINATE EXISTING RWC DEVICES

The elimination of wood burning addresses the reduction in particulate matter emissions from RWC devices by providing incentives for homeowners to remove or disable existing devices in residences. These program elements have two advantages in controlling PM-10 emissions. First, the emission reductions achieved through eliminating existing devices are permanent. They are not intermittent controls that may continue to add to the PM-10 problem in a community even if operating at reduced emission rates. Second, these provisions are readily enforceable. If RWC devices are not removed from a residence and continue to be operated, they can be readily detected.

There are two program elements that have been identified that can be used to eliminate existing RWC devices. The first extends the previously discussed economic incentives to discontinue the use of wood as fuel for space heating to owners of existing RWC devices. The second would use the local authority's regulatory power to require at least certain types of RWC devices be removed from residences and disabled or, in the case of fireplaces, dismantled so they are no longer operational.

4.3.1 Incentives to Remove and Disable Existing RWC Devices

The incentive program to reduce the number of existing RWC devices and the incentive program to encourage homeowners to switch to alternative fuels (described above in Section 4.1.3) are basically the same program element. The goals of the programs are stated differently, but the implementation and results of both program elements are the same.

As with incentives to encourage homeowners and builders to use alternative fuels in new dwellings, incentives to remove or disable existing RWC devices in residences can take a variety of forms. Tax credits or deductions could be offered that would allow the homeowner who removes or disables an RWC device to recover part of the cost of that change by deducting all or part of the cost from the state or local tax bill. Alternatively, a grant from the state or local authority can be provided to defray all or part of the cost to the homeowner of switching the heating system in the residence to some system other than wood heat.

Although tax credits and deductions are frequently used as incentives for obtaining voluntary compliance with a governmental program, establishing these tax incentives requires the cooperation of the legislative body (whether state or local). Consequently, establishing the tax and setting the level of taxation can be a complicated procedure. Similarly, getting funding to undertake a direct payment program can also require legislative action to establish the funding required to make the payments. Consequently, although either measure can be effective in causing RWC devices to be eliminated, they may have high internal costs to the air quality agency.

There are, at present, no existing programs that provide economic incentives that are specifically intended to result in the retirement of a substantial number of existing RWC devices. The effectiveness of any incentive program that might be established would depend on the level of incentive offered and the number of device owners who could be persuaded by that incentive to relinquish their RWC devices. A low level incentive would have only a marginal effect on the number of devices operating in the community and, consequently, only a marginal effect on PM-10 emissions. A higher incentive level (probably substantially higher than the cost of the conversion to another heat source) could result in virtually all RWC devices being removed. Since the need of most localities to reduce PM-10 emissions will probably fall between these two extremes, the incentive level would probably need to be set at some intermediate level.

As with the incentive program elements for fuel switching described above, an incentive program designed to eliminate existing RWC devices would vary in effectiveness over time, with the greatest impact expected in the first year and diminishing somewhat in following years. For each existing RWC device retired and disabled as a result of the incentive program, a credit for 100 percent of the PM-10 emissions from that existing device is recognized in Table 4-1.

4.3.2 Regulatory Prohibition Against Operation of RWC Devices

The most stringent program element designed to limit the population of RWC devices is a regulatory requirement banning the use of RWC devices for residential heating in the community. Such a program element could either be a total ban on all RWC devices, or a partial ban that would extend to certain types of devices. In either case, the effect on particulate matter emissions is immediate and substantial.

A prohibition against RWC devices would eliminate both existing and future PM-10 emissions from the combustion of wood as a heating fuel. Not only would such a measure accomplish a complete reduction in emissions, but it would also be a readily enforceable regulatory measure. The observation of smoke coming from a chimney or flue pipe could be grounds for an inspection of the premises to determine if an RWC device is in operation.

A regulation requiring the removal or disabling of existing RWC devices would be based on the state's authority to regulate sources of air pollutant emissions. Such a requirement would obviously be a politically sensitive act by the local authority in any community, and no total bans are currently in effect. Partial bans on certain RWC devices, most notably fireplaces, have been implemented in communities such as Telluride and Aspen, Colorado.

The effectiveness of a ban on RWC devices could be readily estimated. This measure would reduce PM-10 emissions from the devices subject to the ban by 100 percent. If the ban extended to all RWC devices, the inventory of PM-10 emissions from wood combustion would be eliminated. If the ban extended only to certain types of devices, the portion of the emission inventory represented by emissions from that type of device would be eliminated. It should be noted, however, that a partial ban extending only to certain types of RWC devices may lead homeowners to purchase the remaining devices in greater quantities. This may result in a reduction in PM-10 emissions, assuming that the banned devices have higher emissions than the permitted devices, but would not eliminate those emissions or prevent an increase in PM-10 emissions over time. Consequently, a partial ban may only be a temporary measure in communities where a more stringent control strategy is needed.

Table 4-1 describes effectiveness level for a ban on existing RWC devices. The credit for this program would be 100 percent of the PM-10 emissions from all existing RWC devices removed from residences and disabled. This credit would extend both to new and existing devices. If only certain types of RWC devices are covered by the ban, the credit would extend to all devices of that type that are removed or disabled.

SECTION 5

CURTAILMENT

Episodic curtailment is the fourth category of control measures available for reducing PM-10 emissions from residential wood combustion. Curtailment programs have a very important role in PM-10 SIP's. In its simplest form, a curtailment program element involves the elimination of wood burning during periods (episodes) when ambient levels of PM-10 approach or are predicted to exceed a given level, in this case the NAAQS for PM-10.

Many of the control measures discussed in the previous sections have the potential for affecting long-term, gradual, and permanent reductions in ambient PM-10. By contrast, episodic curtailment is best suited for making short-term, immediate, but significant reductions in ambient levels of PM-10.[1] Episodic curtailment is particularly attractive for meeting the PM-10 ambient standard in those areas where woodstoves and fireplaces emit the most when dispersion characteristics are the worst--resulting in sharp peaks (often less than 10 percent of the heating season) of unacceptably high PM-10 concentrations. In areas where there is a persistent problem with wood smoke, the other control measures will also be necessary. However, in most areas where the wood smoke problem is characterized by both persistence and peak periods, a combination of curtailment and one or more of the other methods would be appropriate. Several programs involve such a linkage. Table 5-1 shows that all curtailment programs have a PA program element that goes beyond simple notification, and most have program elements to attempt to reduce overall PM-10 emissions rather than simply address peak ambient problems.

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[1] Virtually all PM-10 exceedances result from violations of the 24-hour standard although in some cases both the annual standard and the 24-hour are exceeded.

TABLE 5-1. CURTAILMENT[1] AND COMPLEMENTARY PROGRAM ELEMENTS FROM SELECTED RWC EMISSION CONTROL PROGRAMS

Curtailment Program (Mandatory or Voluntary)[2]	Complementary[3] Program Elements
Boise, Idaho (M*)	PA, SL, P, TS, OL
Butte, Montana (M)	PA, OL, P
Denver Area (B)	Cert
Jackson County, Oregon (V)	Cert, PA, grants for income for replacement
Juneau, Alaska (M*)	PA, SL
Lane County, Oregon (V)	PA
Lewis & Clark County, Montana (M)	PA, OL
Missoula, Montana (M*)	PA, TC, P
Puget Sound APCA, Washington (M)	PA
Washington State (M)	PA, Cert, OL, fuel restrictions
Washoe County, Nevada (B)	PA, Cert, OL, Removal of noncertified stoves upon sale of residence

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[1] Sources: Radian interview; Batson, 1987.

[2] Mandatory only (M) Voluntary only (V) Both voluntary and mandatory (B) (M*) Program now mandatory after unsuccessful voluntary program.

[3] "PA" is public awareness that goes beyond simply notifying public when a curtailment is in effect.
"SL" is subsidized, low-interest loan for alternative heating devices and/or clean burning stoves.
"TC" is tax credits.
"P" is permit system.
"Cert" is requiring only certified stoves in new installations.
"TS" is thermal standards or weatherization.
"OL" is opacity limits.

There is a variety of curtailment program types. They can be either voluntary, mandatory, or both--depending upon predicted ambient conditions. Curtailment programs can range from an absolute ban on combustion of all solid fuels (i.e., all coal and wood fired appliances) to the granting of exemptions for certain types of appliances (such as certified stoves or sole-source heaters). Even the simplest curtailment program must have a means of determining when to trigger the "no burn" period and a means to notify the public that a no burn condition is in effect. Finally, a variety of enforcement and effectiveness monitoring approaches are available.

The following discussion explains how a curtailment plan can be drawn up, how the program can be communicated to the public, and how the no burn mandate is monitored and enforced (for the nonvoluntary programs). This section concludes with an estimate of the assumed effectiveness of various approaches to episodic curtailment.

5.1 CURTAILMENT PLAN

In designing a curtailment plan, it is important to carefully consider the issue of voluntary versus nonvoluntary compliance, the affected area, how to gain public acceptance, the method of forecasting no burn periods, and the issue of exemptions. Other aspects of a comprehensive curtailment plan are discussed in Sections 5.2 - 5.4.

5.1.1 Voluntary Versus Mandatory Programs

Because wood burning has traditionally been regarded as a "right" rather than a regulated activity, local elected officials are usually reluctant to impose a mandatory ban on wood burning, preferring instead voluntary no burn periods. As Table 5-1 shows, of the curtailment programs examined in this study, two were voluntary only; eight were mandatory only; and one had elements of both.

The BPA study assessing wood smoke mitigation measures stated that voluntary programs, which are unenforceable, do not achieve more than 15 to 20 percent cooperation. Of the seven communities (cited in the study) with episodic curtailment, five had switched to a mandatory program because of the apparent ineffectiveness of voluntary programs (38).

The most effective reported voluntary program is Washoe County, Nevada, (Reno) where the voluntary phase of the curtailment program results in one-third to one-half of the residents responding positively. One reason for this high rate of participation may be because the action levels are set high. The voluntary program is not triggered until the PM-10 level exceeds or is forecasted to exceed the NAAQS of 150 $\mu g/m^3$ (or 100 PSI[2]). At this point, the visibility is significantly impaired and the public literally sees the value of eliminating wood burning.

Overall, the experience suggests that despite its relative ineffectiveness, a voluntary program could serve several useful purposes. As discussed below, a voluntary program can be used as a first phase of what may eventually become a mandatory program (depending upon public response). For example, officials may introduce episodic curtailment during the first heating season as a voluntary measure in order to increase public acceptance and as an incentive to avoid mandatory curtailment in successive heating seasons. If the public is persuaded through public education efforts to voluntarily curtail wood combustion during air quality episodes, a voluntary program could prove to be an end in itself. A voluntary no burn condition can also be used as the first stage (e.g., a few hours or days) in a period of deteriorating air quality, leading ultimately to the mandatory no burn phase.

In summary, voluntary programs have the advantages of greater public acceptance (although there may be some resentment by those who give up wood burning against those who ignore the no burn requests) and the avoidance of surveillance and enforcement costs. However, as discussed later, mandatory programs are more effective.

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[2] Pollution standard index, where for any NAAQS 100 equals the NAAQS.

5.1.2 Affected Area

For the mandatory programs, the affected area should take into account the concentration of emissions and ambient "hot spots," the ability for program personnel to monitor and enforce compliance, and the means of communication to individual households.

The curtailment program can be limited to a geographic subset of a larger program area involving several control measures. For example, although the Juneau, Alaska, wood smoke control program includes a variety of control measures, the curtailment program is confined to the Mendenhall Valley where approximately half the Juneau area population resides and where topographic and microclimatological features create the highest levels of PM-10 concentrations. Similarly, in Missoula, a mandatory no burn condition is voluntary for rural residences.

Where a state agency is charged with administering the curtailment program--as is the case in Washington--the affected area may include several counties or theoretically the entire state. The Washington statute and regulations allow for the State Department of Ecology to issue a statewide or regional "episode" in which all solid fuel burning must cease. However, local areas, such as the Puget Sound Air Pollution Control Agency, can issue "impaired air quality" alerts which require all but certified woodstoves to stop burning.

On the other hand, problems can arise where the jurisdictional area is smaller than the problem area, as is the case in the Denver Metro Air Quality Council (DMAQC). The DMAQC is a coordinating agency created by the Governor to develop the SIP for the Denver area. It includes the areas covered by six counties and 23 municipalities but has no regulatory authority in and of itself. Communication of no burn days, compliance determination, and enforcement becomes complicated when several jurisdictions are involved. The effectiveness of the Denver area curtailment programs is limited, in part, because of the variety of jurisdictional approaches within an essentially common air shed. Some of the communities have no burn days, some do not; some are voluntary, some are mandatory; and there are varying means of communication and enforcement techniques. For this reason, there is a proposal to consolidate much of the program under the State Department of Health.

5.1.3 Public Acceptance

Officials with programs that have been in effect several years report that resources and attention to public awareness are vital at the inception of a curtailment program, but that after the second or third year the need for public awareness is sharply reduced. These officials also report that it is essential to focus first on informing and persuading local elected officials and the local media of the curtailment program's importance and necessity before broadening the effort to the public.

The success of voluntary curtailment programs is solely dependent upon public acceptance. In these programs the public must be convinced of the need to make an individual sacrifice for a public good (healthier air for the community at large). Therefore, an effective public education program is essential.

For the mandatory programs, public acceptance is also important for at least two reasons: first, curtailment involves the giving up of what has been commonly regarded as a right -- burning wood for space heating. The sacrifice, although temporary, may last several days and often comes at a time when the demand of wood heating may be the greatest. Even if the public is forced to grudgingly go along with the program under threat of fines and penalties, the community's elected leaders may eventually be pressured to eliminate the program. Second, a popular program can create a form of peer pressure against noncompliance that is more thorough and less costly than organized patrolling and surveillance. It is common for neighbors to resent being forced to comply with a no burn requirement while a careless or uncaring neighbor pollutes the air. A form of peer pressure develops to reinforce the exhortations from program officials. This may also result in the reporting of these violations -- often anonymously -- by neighbors.

Public acceptance can be achieved by a PA and education program element, a phase-in of curtailment program elements, and the provisions of wood-burning alternatives for areas where episodes are frequent and/or lengthy. The latter, alternative wood-burning provisions, are discussed in the "Exemptions" section.

5.1.3.1 Public Awareness--

Whether the program is voluntary or mandatory, it is important to inform the public why it is being asked to sacrifice their previously unrestricted right to burn wood. (See Section 2 of this document for a more detailed discussion on PA program elements.) The messages may include the following themes and content:

1. There are health threats of particulates, including the carcinogenic properties of polycyclic organic material and carbon monoxide and the link between these pollutants and wood burning. The Washington State program has developed a very effective approach based on the toxics concern and the issue of indoor air quality.

2. The true economic costs of wood burning may be much higher than most people realize. It is important to provide consumers with a means (1) to calculate the actual costs of wood burning (including the value of homeowner's time for cutting and hauling wood, ash disposal, etc.) and (2) to compare this with alternative heating costs.

3. Citizens need to comply with the PM-10 standard and the legal sanctions that could be imposed on the community if effective measures are not implemented and enforced.

4. It is essential to provide details on how the program will work.

The first message should help generate voluntary acceptance by establishing the need to control wood smoke emissions. The emphasis of the public education program element should be on the health and welfare benefits of reduced wood smoke levels during episodes. The second message may help residents be more tolerant of curtailment and can provide them with data that will allow them to make an informed decision as to whether they should convert to an alternative heating source.

The third message informs the public that episodic curtailment is not a unique nor experimental program confined to their community, but rather it is a response to a national ambient standard that has been selected because of technical review and reasoned analysis. Finally, the fourth message--information about how the program will work--will promote acceptance because it will counteract the inevitable rumors that will occur in the absence of good communication. A description of how the program will work is particularly important if there are exemptions for sole-source heaters and/or certified stoves or if there is a phase-in period.

5.1.3.2 Phase-in of Program Elements--

Program officials in several localities believe that a phased-in approach (rather than a sudden imposition of a curtailment program) has long-term benefits in public acceptance despite the temporary delays in program effectiveness.

The most common phase-in is the voluntary-to-mandatory transition. The phasing-in of a mandatory program has several advantages. First, it allows program officials to establish the forecasting, communication, and effectiveness monitoring elements without having to worry about the logistics and political controversy surrounding surveillance and enforcement. Second, if the voluntary program is sufficiently effective to reduce ambient levels adequately, it may not be necessary to move to a mandatory phase. The public education program element should communicate to the public that if voluntary compliance is successful, there will be no mandatory phase. Therefore, if it is necessary to go mandatory, there should be greater acceptance because it will be apparent that the voluntary approach did not work due to an insufficient response from the public.

In addition to or instead of a voluntary-to-mandatory phasing, the curtailment "action point" can be set such that only during the first heating season relatively few curtailments result. The next season the action point can be set lower (e.g., from a predicted 150 μg/m3 to 100 μg/m3).

Finally, as discussed below, penalties can be phased-in. This is usually accomplished by establishing a graduated set of penalties based upon frequency of violation. For example, a first offense merits a warning ticket; a second, a $50 fine, and the third and subsequent offenses, $150 fines. The warning ticket approach can also be an occasion for public education by having the enforcement personnel distribute pamphlets on the need for the program and the importance of compliance. This has been effective in Juneau.

5.1.4 Forecasting Episodes

An effective program requires that forecasted meteorological conditions, existing ambient levels, and ambient trends be taken into account in order for local officials to accurately call an air pollution alert. The pollution alert triggers the no burn mandate or, for voluntary programs, request. Forecasting should provide enough lead time to communicate to the public and thus avoid the high ambient levels but should not be so premature as to result in "false alarms," which could adversely affect the credibility and acceptability of the program.

Local officials with successful programs report that episode forecasting skills improve with time. Also, the public becomes sensitized to conditions that accompany air pollution emergencies and therefore is often able to presume when the episode is occurring. At a minimum, the forecasting of potential episodes of unacceptably high ambient levels requires access to weather forecasts and the real-time monitoring and reporting of PM-10 ambient levels in the affected areas.

5.1.4.1 Weather Forecasting--

Local program officials should maintain frequent contact with the National Weather Service or other appropriate weather forecasting entities that can determine whether a temperature inversion and conditions favorable to poor dispersion will occur. The Washington State program does not impose a mandatory curtailment until the State meteorologist declares that an air stagnation is in effect, although local programs can use other criteria and methods.

5.1.4.2 Ambient Monitoring --

A system of ambient monitoring of PM-10 levels is also necessary. Many programs use nephelometers or beta gauges as a basis for declaring a curtailment. These have the advantage of providing real-time data. Others use PM-10 reference monitors, which although more accurate, may create delays in calling for a curtailment. Nephelometers, which measure the light scattered by particles in a sample volume of air, have been shown to be accurate in the range of very fine particles (0.1 to 1.0 um's) which includes much of the range for RWC particles. Colorado measures CO as a surrogate indicator (and because CO nonattainment is more of a problem).

Some areas, such as Washoe County, use reference PM-10 samples for official determinations together with beta gauges for hourly readings as an aid in forecasting or to trigger an "action point."

5.1.5 Action Points

All of the curtailment programs have to be triggered by some level of deterioration in air quality called an action point. In some programs, curtailments are triggered by the deterioration of air quality to a certain level plus a prediction by a meteorologist that an air stagnation condition will persist for at least 24 hours. Some programs have several action points: one for implementation of voluntary curtailment, another for when an official may (i.e., at his or her discretion) call for mandatory curtailment, another when mandatory curtailment must go into effect, and perhaps another phase of mandatory curtailment when no exemptions are allowed and all solid fuel burning must cease.

The stringency and the effectiveness of a curtailment program is based, in part, upon the action point. A high action point -- one at or near the PM-10 standard -- will have the advantage of requiring fewer curtailments and may have more public support because the necessity of curtailing burning will be more obvious. However, a high action point is less likely to avoid an exceedance of the standard because the margin between the action point and the standard is narrow. A lower action point, for example at 50 to 70 percent of the standard, will create more curtailments. However, it will, if adequately enforced, provide greater assurance of avoiding an exceedance of the standard, and (because moderately high ambient levels are avoided) will result in generally cleaner air. Table 5-2 lists some of the action points used by some of the programs. Note that four of the programs listed have two action points. The first number is for the first stage (a less stringent, perhaps voluntary stage) and the second action point is for the second stage (a more stringent stage that may not allow exemptions).

5.1.6 Exemptions

Exemptions from mandatory curtailment serve two purposes: (1) humanitarian and (2) as an incentive to replace a relatively high-emitting appliance with a cleaner burning one. Table 5-3 presents the exemptions and criteria for various curtailment programs.

5.1.6.1 Exemptions for Sole Source Heaters and Economic Hardship --

Many of the homes in this country are heated exclusively by wood burning and many use wood as a primary source of heat. Many of these households are low income and thus, unable to easily convert to an alternative fuel.

TABLE 5-2. HOW DIFFERENT PROGRAMS DETERMINE WHEN TO CURTAIL WOOD BURNING[1]

Program Location	Action Points	Comments
Boise	110 $\mu g/m^3$ PM-10	
Butte	100 $\mu g/m^3$ PM-10	Averaged over any 4-hour period - or when predicted.
Denver	9 ppm, CO	Based on CO, not PM.
Jackson Co.	130 $\mu g/m^3$	Voluntary only.
Juneau*	100 $\mu g/m^3$ (air alert) 150 $\mu g/m^3$ (air emergency)	City mgr. may call for curtailment. City mgr. shall call for curtailment. Permitted stoves must shutdown.
Missoula*	100 $\mu g/m^3$ (air alert)	Only certain permitted stoves can burn.
	150 $\mu g/m^3$ (Stage II)	No solid fuel burning in Stage II.
Puget Sound APCA*	90 $\mu g/m^3$ PM-10 100 $\mu g/m^3$ PM-10	Discretionary to call an alert. Must call an alert.
Washoe Co.*	PSI >100 "yellow" PSI >150 "red"	Triggered by either CO or PM-10. A 150 PSI is equal to 250 $\mu g/m^3$.
Lewis & Clark Co.	100 $\mu g/m^3$ TSP	Or when 100 $\mu g/m^3$ is forecast.

[1] Sources: Radian interviews; Batson, 1987.
*Two stages.

TABLE 5-3. EXEMPTIONS TO CURTAILMENT AND CRITERIA FOR QUALIFICATION FOR EXEMPTIONS[1]

Program Location	Exemption Type[2]	Criteria for Exemption
Boise	C.S. S.S. E.H.	(No data)
Jackson Co.	C.S. S.S.	(No data)
Juneau	C.S.	EPA, Phase II Certification
Lewis & Clark Co.	E.H. coal-burners	Must apply and meet income limits. Low sulfur coal only & only existing units.
Missoula	C.S.	Stoves with <4 gph emissions.
	E.H.	Income low, applications are screened.
Puget Sound	C.S. S.S.	(No data)
Washoe Co.	S.S.	Must be confirmed by building inspector.
Butte	C.S.	4.1 gph EPA method (permitted).
	S.S.	Grandfathered units only.
	E.H.	Must qualify for low income assistance.

[1] Sources: Radian interviews; Batson, 1987.

[2] C.S. - Certified stoves.
S.S. - Sole source.
E.H. - Economic hardship

Therefore, it may be appropriate to include either a permanent or temporary exemption for sole source wood heaters for humanitarian reasons. Washoe County provides for a sole-source exemption that is scheduled to phase-out two years after the initiation of the program. Other programs provide for demonstration of hardship exemptions such as low income.

To avoid circumvention (i.e., someone getting rid of their backup or alternative heating source in order to qualify for this exemption), the exemption should apply only to those dwellings that are sole source as of a given date, such as the date that the program is established. It may also be necessary to require that if the house with the exempted device is sold, the house must be equipped with a backup heating system. If a wood-heating survey is conducted in the community as a means of estimating wood smoke emissions (see Appendix A), it may be worthwhile to include questions relating to backup heating devices in order to estimate the number of sole source wood heaters in the community. Finally, the program officials should consider distinguishing between sole source heaters at dwellings that are a principal residence and those that are used for recreation purposes such as hunting cabins.

The use of sole-source exemptions not only serve a humanitarian purpose but they promote public acceptance by the community at large. There is a widespread concern that by banning residential wood combustion, families may go without heat. The use of a sole-source exemption can defuse this argument against episodic curtailment.

5.1.6.2 Exemptions for Clean-Burning Appliances--

An exemption from the no burn mandate is often made for wood-burning appliances that have demonstrated that they are low emitting. Most programs that use this approach grant an exemption to wood heaters that have been certified by either a state program (Oregon or Colorado) or are certified under the U.S. EPA's NSPS wood heater certification program. Some programs link the exemption with an EPA Phase II certification; some require that the emissions be below a certain level based upon certification test results. Others, concerned about the apparent discrepancy between certification laboratory results and in-field performance, are considering limiting the granting of exemptions to a subset of certified stoves believed to have superior in-use emissions control performance. Finally, certain types of wood-burning appliances such as pellet stoves or open fireplaces may be exempted.

There are two advantages to the clean burning appliance exemptions and two potential disadvantages. The advantages of creating these exemptions are (1) it enhances public acceptability by making it possible for some households to continue burning wood without creating the impacts if they were using a conventional wood heater, and (2) it creates an incentive to replace relatively high-emitting conventional stoves with lower emitting catalytic or high-technology noncatalytic stoves. Thus, the curtailment program, which has as its goal the elimination of peak ambient loadings of woodsmoke, can also be used to create an incentive to reduce overall average emissions by speeding up the normal replacement rate of older stoves with newer cleaner burning stoves.

One disadvantage to the practice of granting clean-burning exemptions is that this creates the need for a permit or other tracking system in order to ensure that (1) the dirty stoves are removed, (2) the new stoves meet NSPS requirements, (3) the stoves have been properly installed, and (4) the stoves continue to perform as clean-burning appliances in order to continue to qualify for the exemption. Areas with extreme air quality problems may not be able to grant clean-burning exemptions if they are to attain air quality standards and protect public health.

In order to ensure that the exempted stoves continue to perform as clean-burning appliances, exemptions should be contingent upon a periodic maintenance inspection of a licensed or certified inspector. This would consist of an inspection of the stove's general condition, including the gaskets, doors and bypass dampers, and the periodic replacement of the stove's catalyst, if applicable.

Under a permit approach, permitted stoves are allowed to continue to burn during the curtailment episodes. If a homeowner is challenged by a neighbor or an enforcement officer for having smoke emitting from the chimney, he could produce a permit to show that he had been exempted. In practice, this is rarely a problem because police dispatchers or other central recordkeeping offices can maintain a list of permitted appliances. If the permit is renewable, the expiration of the old permit can serve as an opportunity for building inspectors or chimney sweeps to certify that the unit is still in apparent good working operation (e.g., catalysts continue to light off, no warping, rope insulation in place, etc). This use of police dispatchers becomes impractical in large communities.

The second problem with exemptions for clean burning appliances is that over time, the effectiveness of curtailments for reducing peak ambient conditions will diminish as more and more households are exempted from the no burn mandate. This, however, can be addressed by establishing a staged program: Stage 1--no burn except for permitted stoves; and Stage 2--no burn except for designated sole-source heaters.

There appears to be a general consensus that the types of exemptions should be kept to a minimum. In particular, if the objective is to avoid violating the standard, exemptions for certain solid fuel burning devices such as those exempted under the NSPS (i.e., coal stoves, wood burning cookstoves, furnaces, and fireplaces) should be avoided (31). In summary, if exemptions are to be permitted, they should be confined to either a small subset of clean burning devices or based on economic hardship. Otherwise, it is important that the curtailment apply to all solid fuel-burning appliances (particularly if coal burning is also a problem).

5.1.7 Adopting the Plan

When the state or local community has evaluated the factors described above and has developed a program plan for episodic curtailment, the plan--particularly those that involve mandatory actions--is adopted by an elected body (legislature, county commissioners, or city council). Appendix C includes the ordinances and statutes from most of the programs cited in this section.

5.2 COMMUNICATION STRATEGY

Once the design of a curtailment plan is accomplished and the issues of program scope are resolved, details -- such as how to notify the public of no burn conditions -- must be addressed. This section addresses the external and internal communications. External communication is notifying the public that a curtailment is in effect. Internal communication is the notification of program officials and enforcement personnel that curtailment conditions exist.

5.2.1 No Burn Notification Procedures

Once the decision is made to declare a voluntary or mandatory no burn period, there must be an effective means of communicating this to the affected public. Approaches used include radio and television announcements, newspaper announcements, the use of road signs, and a continuously running tape on a special telephone hotline. Table 5-4 presents the various notification procedures in use.

5.2.1.1 Radio and Television Announcements--

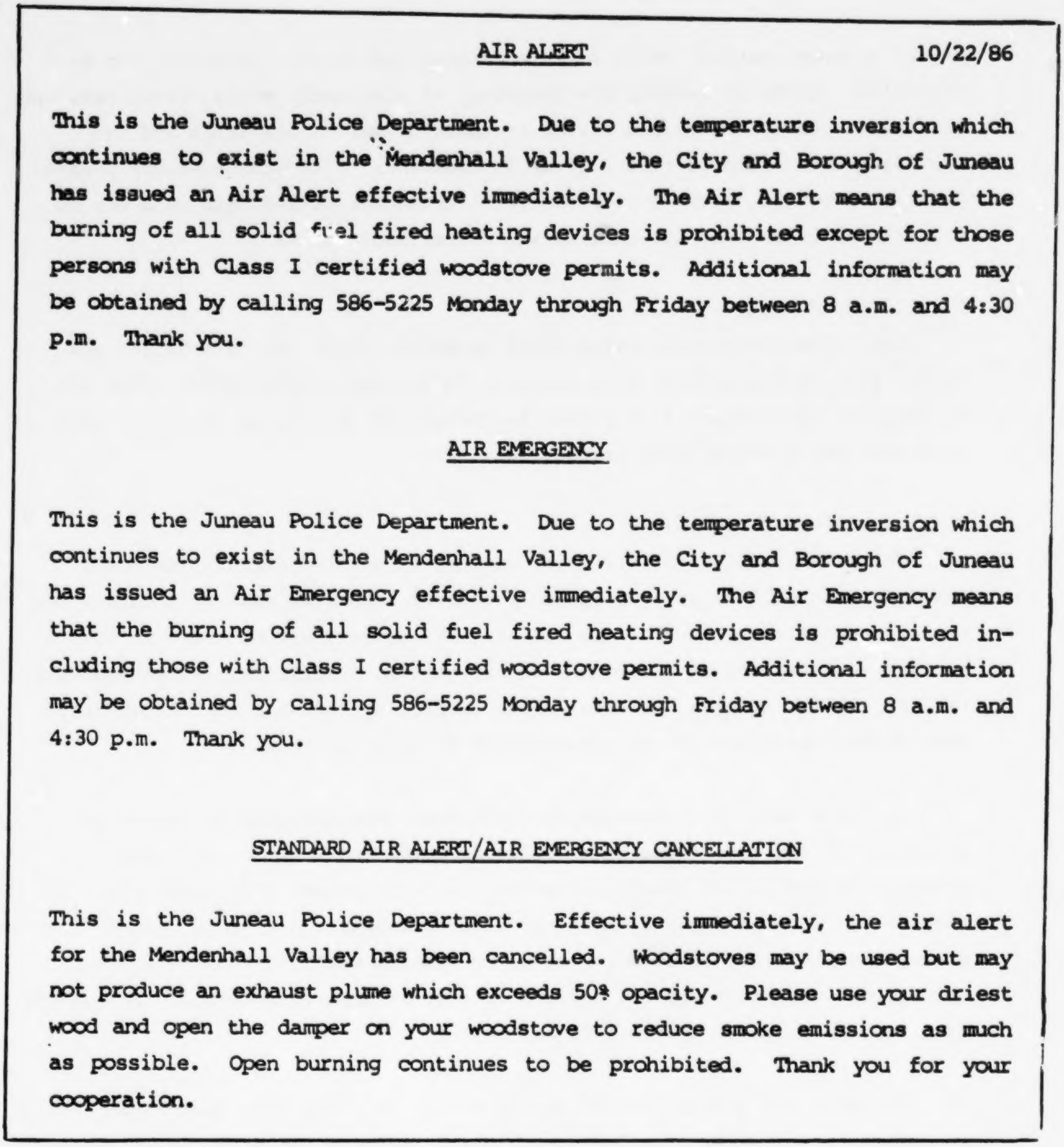
Use of the electronic media to announce a curtailment provides the advantage of immediacy. Some programs provide local radio and television stations with taped announcements that can be used depending upon the stage of curtailment. The text of a prerecorded message from the Juneau program is provided in Figure 5-1. The use of prerecorded tapes ensures that the messages will be accurate and consistent.

5.2.1.2 Newspaper Notices--

If the local community is served by a daily newspaper and if the decision to invoke a curtailment can be communicated to the newspaper before the newspaper's deadline for the evening edition or next morning's edition, the

TABLE 5-4. METHODS OF NOTIFYING RESIDENTS OF NO BURN CONDITIONS

Program Location	Notification Method
Boise, Idaho	• Hotline • Newspaper • TV and radio
Butte, Montana	• Hotline • TV and radio • Newspaper
Juneau, Alaska	• Hotline • Newspapers • 10 folddown road signs • Radio and TV PSAs
Lewis & Clark Co., Montana	• Hotline • Radio & TV PSAs • Newspaper
Washoe Co., Nevada	• Uses red/yellow/green symbols in newspaper • Radio and TV • Hotline



AIR ALERT

10/22/86

This is the Juneau Police Department. Due to the temperature inversion which continues to exist in the Mendenhall Valley, the City and Borough of Juneau has issued an Air Alert effective immediately. The Air Alert means that the burning of all solid fuel fired heating devices is prohibited except for those persons with Class I certified woodstove permits. Additional information may be obtained by calling 586-5225 Monday through Friday between 8 a.m. and 4:30 p.m. Thank you.

AIR EMERGENCY

This is the Juneau Police Department. Due to the temperature inversion which continues to exist in the Mendenhall Valley, the City and Borough of Juneau has issued an Air Emergency effective immediately. The Air Emergency means that the burning of all solid fuel fired heating devices is prohibited including those with Class I certified woodstove permits. Additional information may be obtained by calling 586-5225 Monday through Friday between 8 a.m. and 4:30 p.m. Thank you.

STANDARD AIR ALERT/AIR EMERGENCY CANCELLATION

This is the Juneau Police Department. Effective immediately, the air alert for the Mendenhall Valley has been cancelled. Woodstoves may be used but may not produce an exhaust plume which exceeds 50% opacity. Please use your driest wood and open the damper on your woodstove to reduce smoke emissions as much as possible. Open burning continues to be prohibited. Thank you for your cooperation.

Figure 5-1. Text of pre-recorded message from the Juneau Program.

use of a canned notice, which could accompany the weather forecast, can be effective. Although lacking the immediacy of electronic media, newspapers can reach some people who do not listen to radio or watch television and can provide a more official record of an announcement. The Washoe County program has worked out an approach with the local newspaper to indicate each day on the front page ambient air quality and curtailment status.

5.2.1.3 Road Signs--

Some communities have established permanent signs that are hinged and locked shut during periods when there is no episodic curtailment. When the curtailment is invoked, a city crew is dispatched to open up the signs that announce that a curtailment is in effect.

5.2.1.4 Telephone Hotline--

The most essential notification element is a telephone hotline where residents can call to get a constantly updated recording that will inform the caller whether curtailment is in effect. The message may be combined with a weather forecast and/or a forecast of air quality conditions. To accommodate several callers at once, most telephone companies provide a service whereby simultaneous messages can be communicated through multiple lines.

As noted earlier, residents in areas that have experienced severe air quality problems associated with woodsmoke pollution know, or at least strongly suspect, when conditions exist that will create these problems. If they do not see the signs or hear the radio messages and if they suspect that a curtailment may be in effect because of reduced visibility or cold, still conditions, they can call the hotline to confirm their suspicions. An example of a taped message is provided in Figure 5-1.

A simple and graphic way of communicating to the public when a two-staged curtailment program is in effect is to use a system of color notices: green (okay to burn), yellow (either voluntary or partial mandatory curtailment), and red (mandatory or most stringent curtailment in effect). The three periods can be easily communicated because of the familiar analogy to a traffic light. A copy of the Reno daily newspaper with its graphic presentation of pollution and curtailment levels (which appears each day throughout the heating season) is shown in Figure 5-2.

5.2.2 Internal Communications

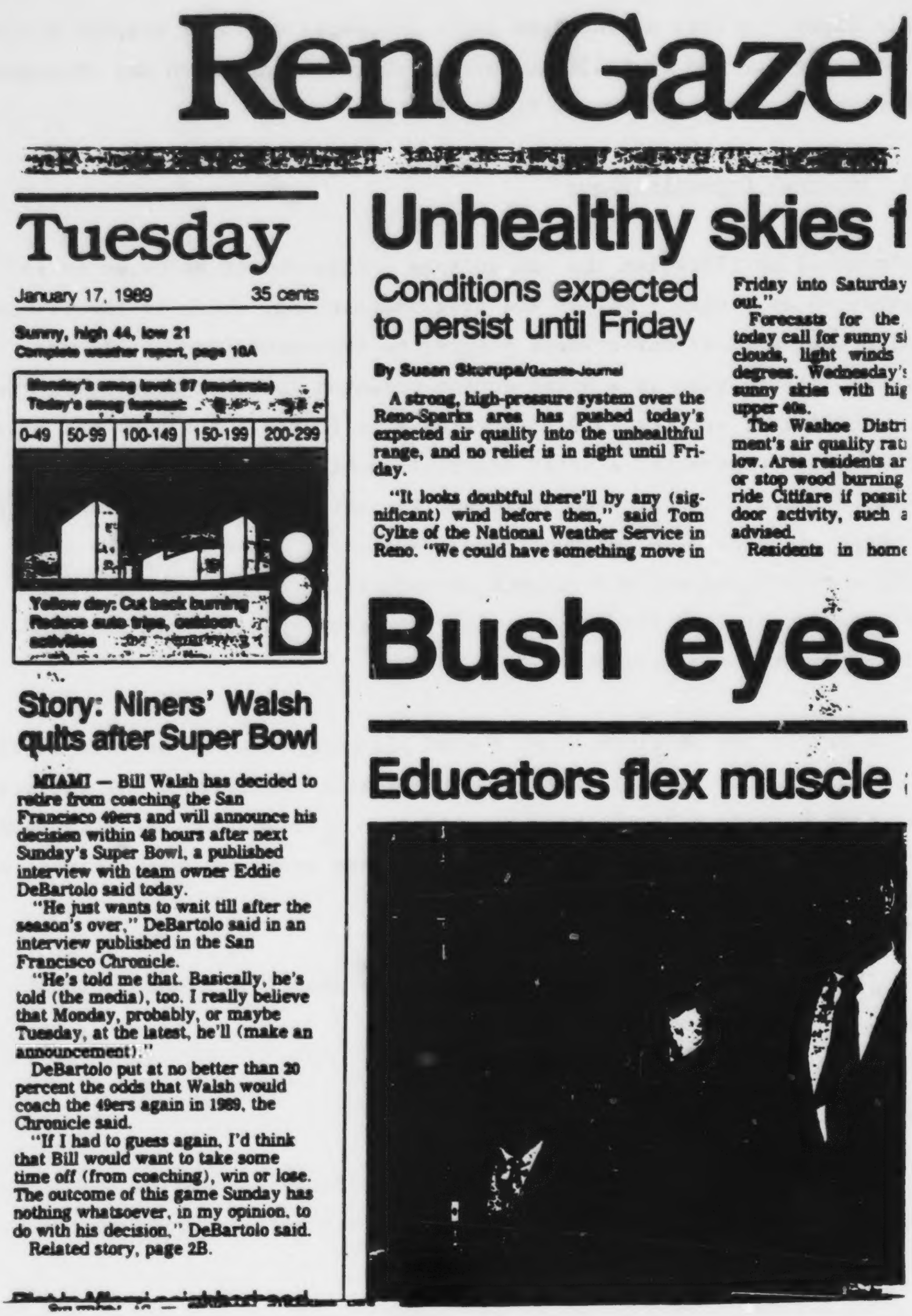
Internal notification that an episode exists should be based on an emergency episode plan. Unlike the program planning, which is the process of deciding what kind of curtailment program to implement (Sec. 5.1), the emergency episode plan is a brief action-oriented document that designates responsibilities, actions, and associated time frames. The plan may include the following components: a brief description of the overall curtailment program, a description of each stage and the action points associated with each stage, and the means of public notification. These plans may also include surveillance and enforcement procedures. (Some guidance and an illustrative ordinance for dealing with emergency episodes can be found in 40 CFR 51, Subpart H and Appendix L.)

The key to the development of a good planning document is that it clearly sets out who should do what, when, and under what conditions. At the beginning of each heating season, those concerned in implementing the plan--air quality staff, police, building inspectors, news media representatives, etc., should meet to review their respective roles.

Both internal and external communications should be simple, direct, and routine.

5.3 SURVEILLANCE

This section presents two kinds of surveillance, discusses the issues of nighttime surveillance, and the timing of surveillance relative to the initiation of the curtailment.



Reno Gazet

Tuesday

January 17, 1989 35 cents

Sunny, high 44, low 21
Complete weather report, page 10A

Monday's smog level: 97 (moderate)
Today's smog forecast: [illegible]

0-49	50-99	100-149	150-199	200-299

Yellow day: Cut back burning. Reduce auto trips, outdoor activities [illegible]

Story: Niners' Walsh quits after Super Bowl

MIAMI — Bill Walsh has decided to retire from coaching the San Francisco 49ers and will announce his decision within 48 hours after next Sunday's Super Bowl, a published interview with team owner Eddie DeBartolo said today.

"He just wants to wait till after the season's over," DeBartolo said in an interview published in the San Francisco Chronicle.

"He's told me that. Basically, he's told (the media), too. I really believe that Monday, probably, or maybe Tuesday, at the latest, he'll (make an announcement)."

DeBartolo put at no better than 20 percent the odds that Walsh would coach the 49ers again in 1989, the Chronicle said.

"If I had to guess again, I'd think that Bill would want to take some time off (from coaching), win or lose. The outcome of this game Sunday has nothing whatsoever, in my opinion, to do with his decision," DeBartolo said.

Related story, page 2B.

[illegible]

Unhealthy skies f

Conditions expected to persist until Friday

By Susan Skorupa/Gazette-Journal

A strong, high-pressure system over the Reno-Sparks area has pushed today's expected air quality into the unhealthful range, and no relief is in sight until Friday.

"It looks doubtful there'll by any (significant) wind before then," said Tom Cylke of the National Weather Service in Reno. "We could have something move in Friday into Saturday
out."

Forecasts for the
today call for sunny s
clouds, light winds
degrees. Wednesday's
sunny skies with hig
upper 40s.

The Washoe Distri
ment's air quality rat
low. Area residents ar
or stop wood burning
ride Citifare if possit
door activity, such a
advised.

Residents in home

Bush eyes

Educators flex muscle

Figure 5-2. Newspaper notification in Washoe Co.

Reproduced from
best available copy.

Surveillance is the act of observing individual households to determine whether or not the public has responded to the notice that a curtailment is in effect. Two types of surveillance are windshield surveys and citizen complaints. Depending on whether the program is voluntary or not, the surveillance may be followed by enforcement actions. For voluntary programs, occasional surveillance is important to determine the effectiveness of the voluntary effort.

Surveillance may be accomplished by "windshield inspections" conducted by police or other personnel during the day or by specially trained observers or special devices and training for detecting nighttime emissions. Windshield inspections may be accomplished by requiring police on routine neighborhood patrols to watch for smoke plumes from chimneys during no burn periods. If a plume is detected the police may decide to radio the dispatcher to inquire whether the house is entitled to burn by virtue of a sole source or clean burning appliance exemption before instituting enforcement actions. If the city is large enough to have a full-time zoning enforcement or building inspection staff, these personnel may be used in lieu of or in addition to the police for surveillance purposes.

Advantages of using police rather than other city or county staff are that (1) police can combine surveillance and enforcement, since they are trained and legally empowered to issue citations and make arrests, if necessary; and (2) police have access to a 24-hour dispatcher who can receive complaints from residents about violations of the curtailment. However, the disadvantage of using police is that police consider wood smoke complaints and violations to be of lower priority than their other responsibilities. Also, police may lack the technical ability of health department staff or building inspectors to counsel residents on the health effects of woodburning, safety considerations associated with improper installations, and how to improve wood-burning efficiency.

As noted earlier, leads on probable noncompliance often originate by citizens who complain, usually anonymously. Table 5-5 shows various means by

TABLE 5-5. METHODS OF SURVELLIANCE FOR IDENTIFYING CURTAILMENT NONCOMPLIANCE[1]

Program Location	Who Conducts Surveillance[2]	Comments
Boise	C.C.	
Butte	Staff	
Jackson Co.	None	
Juneau	C.C., police and staff	Used dog catchers at one time.
Missoula	C.C., staff	
Puget Sound	C.C., off-duty firemen, staff	
Washoe Co.	C.C., staff	Health dept. staff deployed in 15 two-man teams.
Lewis & Clark Co.	C.C., police staff	

[1] Sources: Radian interviews; Batson, 1987.
[2] C.C. = citizen complaints.
Staff = staff of local air pollution or health agency.

which curtailment violations are observed and reported. Citizen complaints are the most common form of surveillance.

Most woodburning occurs at night when temperatures are coldest and residents are home to enjoy the esthetics of a wood fire. This creates a two-fold problem for surveillance. First, the availability of potential staff to conduct surveillance is less because most government employees work during the day. Second, nighttime woodburning is also more difficult to detect and therefore may require special training or the use of special equipment such as spotlights. However, some program officials, such as in Washington State, report that in most urban and suburban areas nighttime emissions are not difficult to detect even without special training or equipment. Some surveillance has been attempted through the use of infrared cameras (22).

Finally, most programs have taken into account the fact that once a curtailment is declared, it is not possible to immediately extinguish fires and thereby immediately eliminate smoke emissions. Therefore, a one to three hour grace period is allowed in order for the fires to burn down. For this reason, surveillance and enforcement should not commence until the grace period is over.

5.4 ENFORCEMENT

Although related to surveillance, enforcement is the act of officially charging violators with noncompliance. Most enforcement schemes rely on a graduated series of penalties increasing with repeat offenses. In some programs the slate is wiped clean at the end of the heating season. In others, the accumulation of penalties occurs over a period of years.

As Table 5-6 indicates, fines often are generally set at a level (i.e., more than $10) that overcomes whatever marginal economic benefits there may be for burning wood versus alternative fuels. This is important, otherwise it would be cheaper to pay the fines.

TABLE 5-6. PENALTIES AND DISINCENTIVES FOR NONCOMPLIANCE

Program Location	Fine Schedule	Other Disincentives/Comments
Butte	1 - $25 2 - $50 3 - $100 - 500	Have to appear in police court.
Juneau	1 - $50 2 - $500	Violators names listed in newspaper.
Lewis & Clark Co.	1 - $25 2 - $50 3 - $75	
Missoula	1 - $20 2 - $50 3 - $100	All are criminal violations. Court appearance required.
Puget Sound	1 - $50 2 - $100 3 - up to $1000	
Washoe Co.	1 - $100 - 250 2 - $200 - 500	Uses highly publicized enforcement teams in marked vehicles.
Yakima, Washington	1 - None 2 - $25 3 - $50 4 - $100	

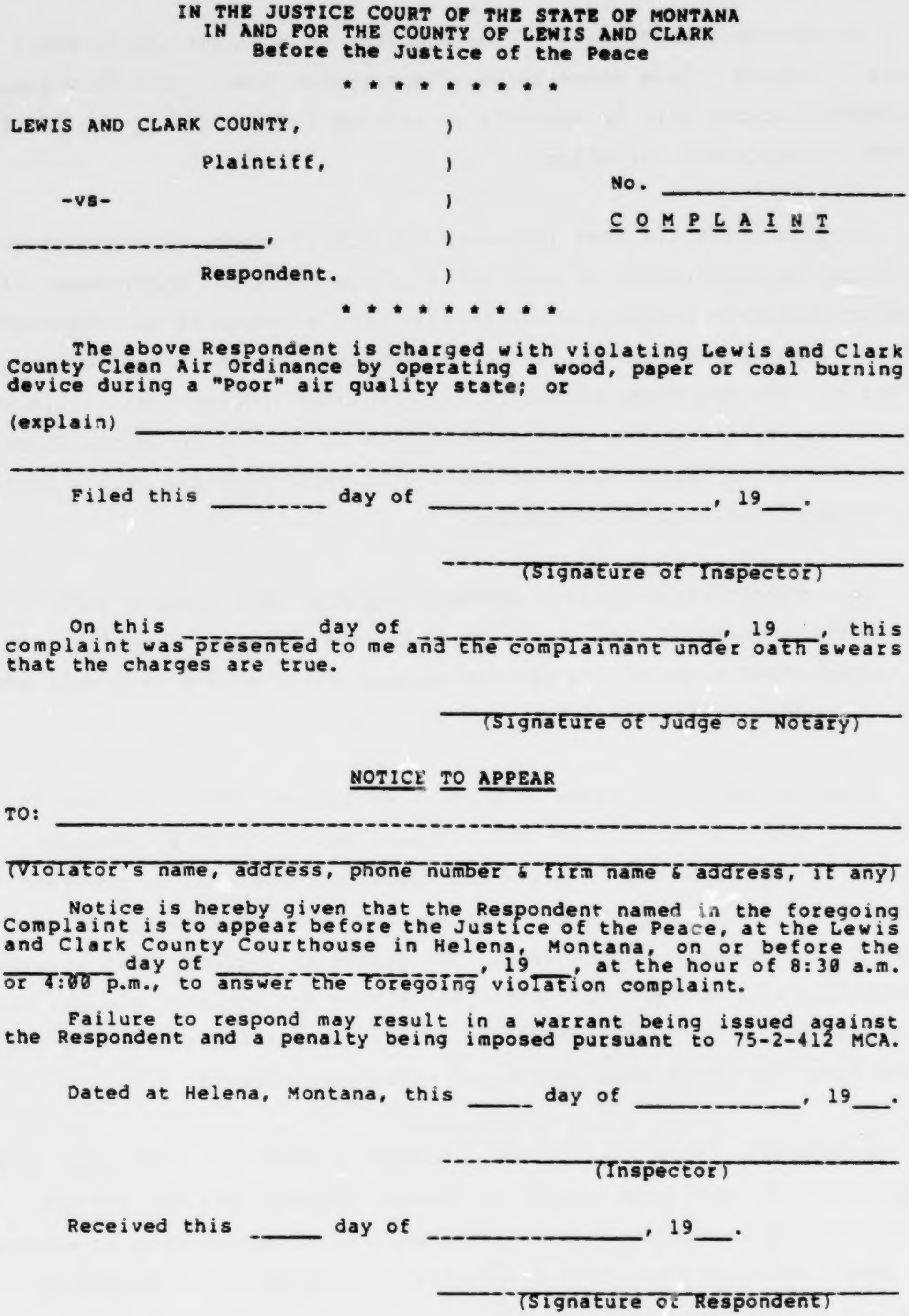
On the other hand, most of the programs do not immediately begin issuing fines. Instead, there seems to be a progression from a voluntary program to a mandatory program with an emphasis on warning tickets during the first several months of mandatory curtailment.

Program officials have increased the effectiveness of their program by securing the cooperation of news media to publicize the enforcement efforts. Program officials report that where publicity accompanies an enforcement effort--such as the publication of the names of persons issued notices of violation--the deterrent effect is significantly increased at little extra cost to the program. The most extreme form of this is in Washoe County, where television crews follow staff vehicles with their flashing yellow lights to the homes of curtailment violators.

This penalty-by-publicity approach requires that program officials secure the support of the local news media and the general public. This can be accomplished by briefings and one-on-one sessions with newspaper editors before program implementation.

Most jurisdictions issue Notices of Violations (NOVs) similar to traffic tickets. Some can be paid by mail; others require court appearances. An example of the form used in Lewis and Clark Co., Montana, is provided in Figure 5-3. In the Puget Sound program, the NOVs are sent by mail rather than given to the violator on the spot. The reason is twofold: (1) it avoids the possibility of a violent confrontation between the violator and the staff person or police officer, and (2) it allows the persons performing the surveillance to cover more ground and write more tickets.

In general, there seems to be a consensus that: (1) a program that is mandatory, with sufficient staff to conduct surveillance and enforce, and with penalties high enough to overcome the benefits of woodburning is effective; and that (2) it only requires a relatively small amount of enforcement effort to yield a good response.



IN THE JUSTICE COURT OF THE STATE OF MONTANA
IN AND FOR THE COUNTY OF LEWIS AND CLARK
Before the Justice of the Peace

* * * * * * * * * *

LEWIS AND CLARK COUNTY,)
Plaintiff,)
-vs-) No. ____________________
____________________,) COMPLAINT
Respondent.)

* * * * * * * * * *

The above Respondent is charged with violating Lewis and Clark County Clean Air Ordinance by operating a wood, paper or coal burning device during a "Poor" air quality state; or

(explain) ____

____

Filed this ________ day of ______________________, 19___.

____
(Signature of Inspector)

On this __________ day of ______________________, 19___, this complaint was presented to me and the complainant under oath swears that the charges are true.

____
(Signature of Judge or Notary)

NOTICE TO APPEAR

TO: ____

____
(Violator's name, address, phone number & firm name & address, if any)

Notice is hereby given that the Respondent named in the foregoing Complaint is to appear before the Justice of the Peace, at the Lewis and Clark County Courthouse in Helena, Montana, on or before the ________ day of ____________________, 19___, at the hour of 8:30 a.m. or 4:00 p.m., to answer the foregoing violation complaint.

Failure to respond may result in a warrant being issued against the Respondent and a penalty being imposed pursuant to 75-2-412 MCA.

Dated at Helena, Montana, this _____ day of ____________, 19___.

____
(Inspector)

Received this _____ day of ________________, 19___.

____
(Signature of Respondent)

Figure 5-3. Example of violation notice form used in Lewis and Clark County.

5.5 PROGRAM EFFECTIVENESS/CREDITS

A few programs have developed data indicating the effectiveness of their voluntary and mandatory programs. The most convincing data are those that are derived from several seasons of ambient air quality data (such as excursions over a heating season, peak values before and after program) from areas where wood smoke is known to be the only or predominate factor in high PM-10 values. Table 5-7 presents effectiveness data from several programs including those from Juneau and Missoula which appear to meet the criteria stated above.

Tables 5-8 and 5-9 present the recommended features for acceptable voluntary and mandatory curtailment program elements. Effective voluntary and mandatory curtailment programs should provide for regulatory authority, planning, and resources to implement the program features listed in Tables 5-8 and 5-9, respectively. Because each community is unique in some aspects of its air quality problem and level of public support, it is neither possible nor prudent to prescribe a curtailment program in detail. The circumstances in each particular community may dictate emphasis or de-emphasis of specific features.

Table 5-7 contains reported curtailment program effectiveness levels. The data are limited and there is variability in the reported effectiveness among programs. Nonetheless, the table provides useful information. Based on knowledge of these specific programs and their strengths and weaknesses, the technical review committee determined that a credit of 10 percent would be given voluntary curtailment programs and 50 percent credit would be given to mandatory curtailment programs. In particular, it was noted that the Washoe County Health Department's highly effective program had a trigger level well above the PM-10 NAAQS when these effectiveness data were taken. This is likely to foster unusually high public cooperation because the concentrations are high enough to be of aesthetic, as well as health concern. The Juneau effectiveness is based only on improvements in monitored concentrations and factors other than wood stove curtailment could contribute to that improvement. The credit for mandatory fireplace curtailment was set at 60 percent. The technical review committee based this credit in part on the fact that, in

TABLE 5-7. REPORTED CURTAILMENT PROGRAM EFFECTIVENESS LEVELS

Program Location	Reported Effectiveness		Method/ Assumptions
	Overall[1]	Peak[2]	
Washoe Co.			
Mandatory (Red)	--	90%	Visual survey of chimneys.
Voluntary (Yellow)	--	33-50%	Visual survey of chimneys.
Jackson Co.			
Voluntary	--	25%	Visual survey of chimneys.
Juneau	--	85%	Monitored ambient air: ● Reductions in highest levels over past five years.
		86%	● Reductions in 2nd highest levels over past five years.
Yakima			
1986 Voluntary		16%	Percentage reduction in 1st and 2nd (averaged together) hourly readings over previous season. (Batson, 1987).
1987 Mandatory		38%	

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[1] Approximate percentage of emission reductions over the heating season based on total woodsmoke emissions.

[2] Approximate percentage reduction in emissions for peak PM-10 episodes (e.g., design day).

TABLE 5-8. RECOMMENDED FEATURES FOR A VOLUNTARY CURTAILMENT PROGRAM ELEMENT

Program Feature	Discussion
Public Awareness	Vital for success of program. Should be at a level similar to the Level II example in Section 2 of this document. Should be strong on persuasion.
Staging/Phasing	Not necessary or appropriate.
Prediction of when to call the curtailment	Use of both air quality data and meteorological data. Air quality data should include at least one real time (i.e., hourly) monitor -- preferably a beta attenuation monitor.
Where to set action point	• Level should avoid an exceedance of the standard by setting action point at below 150 $\mu g/m^3$. • Should use hourly trend data to make preemptive call. • Should avoid high (>15) number of calls during a season in order to avoid a disgruntled, and therefore less responsive, public.
Notification to public that a curtailment is in effect	• Local media (all TV/radio stations and daily paper). • Telephone hotlines. • If no local media, conspicuous signs.
Exemptions	• Sole source. • Low income. • EPA Phase II certified stoves (only in certain situations).
Surveillance/Enforcement	No enforcement but there should be some effort to identify and, at least occasionally, notify those who appear to be disregarding the voluntary curtailment.
Tracking	Before and after windshield surveys (counts of smoking chimneys) in order to determine actual effectiveness.
Effectiveness	• Assumed to be 10 percent of all RWC devices affected (i.e., after application of other control measures and elimination of exempted devices). • If tracking shows higher effectiveness data, these data may be used in subsequent years.

TABLE 5-9. RECOMMENDED FEATURES FOR A MANDATORY CURTAILMENT PROGRAM ELEMENT

Program Feature	Discussion
Public Awareness	Needed for success of program. Should be at a level similar to the Level II example in Section 2 of this document.
Staging/Phasing	• Staging. Could make program progressively more stringent (e.g., lower action points, stiffer fines, more aggressive enforcement, etc.) with each season in order to get public accustomed to program. Or could make voluntary program a first stage. • Phasing. Should include two phases tied to exemptions (if exemptions are allowed). First phase allows exempted units to continue burning; second phase requires all but economic hardship units to stop burning.
Prediction of when to call the curtailment	Use of both air quality data and meteorological data. Air quality data should include at least one real-time (i.e., hourly) monitor -- preferably a beta attenuation monitor.
Where to set action point	• Level should avoid an exceedance of the standard by setting action point at below 150 $\mu g/m^3$. • Should use hourly trend data to make preemptive call. • Should avoid high (>15) number of calls during a season in order to avoid a disgruntled, and therefore less responsive, public.
Notification to public that a curtailment is in effect	• Local media (all TV/radio stations and daily paper). • Telephone hotlines (with multiple lines if necessary to accommodate calls).
Exemptions	• Sole source. • Low income. • EPA Phase II certified stoves (only in certain situations).

(Continued)

TABLE 5-9. (Continued)

Program Feature	Discussion
Surveillance/ Enforcement	• Provide for nighttime enforcement by having equipment and personnel necessary to spot nighttime burning. • Encourage citizen complaints. • Publicize enforcement efforts to ensure that public is aware that enforcement is occurring and to "shame" violators. • Levy fines that are high enough to discourage woodburning. For most communities $50 first time offense, $75 and $100 for subsequent violations is sufficient.
Tracking	• Before and after windshield surveys (counts of smoking chimneys) in order to determine actual effectiveness. • Compare level of ticketing with program effectiveness to ensure that enforcement effort has "teeth" in it.
Effectiveness	• Assumed to be 60 percent of all fireplaces and 50 percent for all stoves affected (i.e., after application of other control measures and elimination of exempted devices). • If tracking shows higher actual effectiveness data, these may be substituted for future years.

their experience, fireplace users were potentially more cooperative with curtailment programs than are wood stove users.

These credits are presumed appropriate if the program features in Tables 5-8 and 5-9 are reasonably well addressed. If a program is particularly strong in regard to these features, it may justify a higher credit, conversely, inadequate consideration of these program features may warrant a credit lower than those listed.

SECTION 6

REFERENCES AND SOURCE MATERIAL

6.1 LIST OF PERSONAL CONTACTS

Much of the information presented in this document is based primarily on informal telephone interviews with state/county/city officials who administer their PM-10 programs. Table 6-1 provides the names of the officials interviewed, the names and geographic locations of their agencies, and the date of the interviews. The reference number for each interview corresponds to the reference number cited elsewhere in this document.

6.2 WRITTEN REFERENCES

Table 6-2 is a list of source material - exclusive of personal interviews - that is cited elsewhere in this document. The reference number for each source material corresponds to the reference number that appears in the text.

6.3 BIBLIOGRAPHY

Table 6-3 lists printed material related to PM-10 and RWC topics but was not used as reference material in this document.

TABLE 6-1. LIST OF PERSONAL CONTACTS

Reference Number	Contact
1	Banner, B. Okanogan County Health District, Okanogan, Washington, 13 January 1989.
2	Bashian, B. Fresno County Air Control District, Fresno, California, 11 January 1989.
3	Bateman, B. Bay Area Air Quality Management District, San Francisco, California, 10 January 1989.
4	Bonderson, N. Auburn County Air Pollution Control District, Cloverdale, California, 6 January 1989.
5	Church, S. Missoula City/County Health Department, Missoula,Montana, 16 December 1988.
6	Crank, B. and J. King. Town of Crested Butte, Crested Butte, Colorado, 1 January 1989.
7	Drabeck, J. Department of Ecology Air Programs, Redmond, Washington, 21 December 1988.
8	Fackrell, J. City Housing Department, Boise Idaho, 20 December 1988.
9	Gilbertson, S. and T. Chapple. City Borough of Alaska, Juneau, Alaska, 10 January 1989.
10	Golden, K. Washoe County Health Department, Reno, Nevada, 19 January 1989.
11	Hardeback, E. Great Basin Unified Air Pollution Control District, Mammoth Lakes, California, 10 January 1989.
12	Johnson, R. Lane County Air Pollution Control Agency, Springfield Oregon, 29 December 1988.
13	Jordan, C. Tahoe Regional Planning Agency, Lake Tahoe, California, 13 January 1989.
14	Kuyper, B. Denver Metro Air Quality Council, Denver, Colorado, 4 January 1989.

(Continued)

TABLE 6-1. (Continued)

Reference Number	Contact
15	Larson, R. Butte-Silver Bow Health Department, Butte, Montana, 21 December 1988.
16	Maykutt, N. Puget Sound Air Pollution Control Authority, Seattle, Washington, 17 January 1989.
17	Mileham, M. Oregon Department of Environmental Quality, Portland, Oregon.
18	Morgan, W. Northern Sierra Air Quality District, 10 January 1989.
19	Nelson, B. and L. Cassin. Aspen/Pitkin County Environmental Health Department, Aspen, Colorado, 19 December 1988.
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27	Zopf, M. Routt County Department of Environmental Health, Steamboat Springs, Colorado, 9 January 1989.
28	Harley, Bob. City of Albuquerque, New Mexico. February, 1989.

TABLE 6-2. WRITTEN REFERENCES

Reference Number	Reference
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(Continued)

TABLE 6-2. (Continued)

Reference Number	Reference
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TABLE 6-2. (Continued)

Reference Number	Reference
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APPENDIX A
TECHNIQUES FOR ESTIMATING RWC EMISSIONS

APPENDIX A

TECHNIQUES FOR ESTIMATING RWC EMISSIONS

The estimation of emissions from residential wood combustion is necessary in order to determine the initial level of emissions that must be reduced in order to achieve ambient air quality goals. These emissions must be estimated in two ways. First, an estimate of seasonal emissions of PM-10 from wood combustion is necessary to determine the quantity of emissions that must be reduced throughout the heating season. These reductions address chronic particulate matter problems and potential violations of the annual PM-10 NAAQS of 50 $\mu g/m^3$. A seasonal emission estimate is also necessary to assess the ability of long-term program elements, such as certification, to achieve emission reductions over the course of a heating season.

In addition to seasonal emissions, it is necessary to determine emissions of PM-10 on a "design day" basis. The design day is the theoretical or actual worst case, day on which PM-10 emissions from RWC devices (and other sources) are expected to be the greatest. The design day emissions are important because these are the days on which the 24-hour PM-10 NAAQS is most likely to be exceeded. Control of emissions on the design day is necessary to prevent episodic exceedances of the NAAQS. Although almost all PM-10 NAAQS violations occur because of exceedances of the 24-hour standard of 150 $\mu g/m^3$, SIPs must evaluate both the annual and the 24-hour standards.

HOUSEHOLD SURVEY DESIGN

An essential part of the emissions estimation process is the household survey. The household survey is intended to obtain information on patterns of combustion for residential heat, the types of wood burned for residential heating, the types RWC devices in use, and the numbers of each type of RWC device installed in the community. It is imperative that planners do not "make do" with a survey from another area. Due to changes in wood use over the past several years, the importance of a contemporaneous survey is emphasized. This section describes the major factors to consider in the design and implementation of an RWC survey. Additional information on this topic can be found in reference 16 of this appendix.

The design and planning of the survey should begin with a clear statement of the objectives of the survey and the uses for the data to be obtained. For instance, surveys may be designed to obtain information on the numbers and types of RWC devices in use. They may also be designed to gather information on the perceptions and attitudes of the public on RWC emissions and control strategies. Further, initial surveys may be used to provide a basis for future surveys, enabling the air quality agency to track the effectiveness of the control strategy adopted. In designing the survey, the goals to be addressed should be stated clearly so that the best sample can be selected and the most appropriate questions included in the questionnaire. The survey design, including the questionnaire, should be reviewed by the individuals at the agency who will be using the data, as well as by an outside expert in survey techniques. Pretesting the questionnaire by administering it to a small group (possibly agency staff members) could help eliminate problems with the wording or format of the questions.

The sample chosen for administration of the survey should be representative the relevant population of the community as a whole. Generally, this means that the size of the sample must be statistically adequate to represent that population. Guidelines for estimating an adequate sample size for a survey can be found in reference 16.

In addition to the size of the sample, it is also necessary to consider the makeup of the sample chosen. Depending on the goals of the survey, specific categories of individuals who own RWC devices may be considered separately from the population as a whole. In this case, the sample needs to be selected to assure that those individuals are included in adequate numbers. Similarly, if permanent residents of a resort community (e.g., Aspen, Colorado) are to be distinguished in their RWC operation practices from transient residents, the size and composition of the sample, as well as the method for distributing the survey questionnaire, should be designed to include this group.

The total costs of a household survey consists of several inputs. Mailing lists may be purchased from companies that supply this service, or may be constructed from existing public records. If the latter source is chosen, the cost of labor by agency personnel to construct this list should be considered. Review of the survey questionnaire by a consultant and presentation of the results of the review should also be included in the budget. Materials for the survey include paper and envelopes. Both outgoing and return envelopes should be included. Postage costs should also include both the original distribution of the survey, as well as the return of the responses.

The survey questionnaire should be accompanied by a cover letter from the agency discussing the purpose of the survey, the importance of the recipient's input, and the confidentiality of the responses. The cover letter should also explain the mechanics of returning the questionnaire, and provide the telephone number and address of a contact person who can answer questions about the survey. An example cover letter and questionnaire can be found in an attachment at the end of this appendix.

The questions in the survey should be designed and worded to elicit specific information. This will not only help ensure that the data collected will address the goals of the survey, but will also avoid ambiguity in responses and interpretation. Where possible, respondents should be given alternative responses (e.g., multiple choice questions), or else the form or mode of response should be specified (e.g., by specifying how to indicate the response chosen or what information to use to fill in a blank). Some individual information should also be requested to give an indication of the representativeness of the sample (e.g., age, income, zip code, number in household).

When information has been gathered through the use of the survey on residential wood heating, the six steps outlined below should be followed to estimate both seasonal and design day emissions of PM-10.

In some locations and circumstances, some information necessary to estimate RWC emissions may be available without conducting a household survey. For instance, in regions where most firewood is cut from public lands, land management agencies such as the U. S. Forest Service may be a source of data on the amount and types of wood used as fuel in a community. Similarly, in areas where most wood fuel is purchased rather than being cut or gathered by consumers, wood suppliers may be a valuable source of information on the quantity of wood combusted. Retailers of wood stoves are also a good source of information on the types of new devices being purchased and installed in a community. The use of these sources of information may reduce the cost and burden of a household survey. However, the information available through these means may not provide some of the data necessary for a reasonably complete and accurate estimation of RWC emissions.

CALCULATING RWC EMISSIONS

This subsection describes a recommended methodology for using the survey results to derive emission estimates. The overall approach for estimating PM-10 loading from RWC devices includes estimation of wood consumption by appliance type, application of adjustment factors to account for site specific fuel characteristics and the multiplication by emission factors for each appliance type. Determination of winter design day emissions rates is made by apportioning seasonal wood consumption by heating degree days, and estimating RWC emission for a typical day during the heating season or the month with the highest number of heating degree days. Alternatively, design day emissions can be estimated based on conservative assumptions about the number of RWC devices being used and the number of hours they are operated.

The efficiency and emissions performance of certified noncatalytic and catalytic stoves may degrade over time. In addition to deterioration of the catalyst, seals (e.g., dampers and gaskets) can become damaged or blocked and change the flow of combustion air. Although scant data are available, assumptions can be made which consider the possible effects of performance degradation.

For example, one might assume that as efficiency degrades, the stove moves closer to taking on the heating efficiency and emissions characteristics of a conventional stove, and that its performance can never be worse than a conventional stove. It can also be assumed that the degradation of both efficiency and emissions are in equal proportional steps. For example, if a certified stove's heating efficiency degrades by 10 percent of the difference in heating efficiency between certified stoves and conventional stoves, the emissions will also degrade by 10 percent of the difference in emissions between certified stoves and conventional stoves. Assumptions can also be made about the frequency of catalyst replacement. This is based on information obtained since the regulatory impact analysis for the NSPS wood stoves which assumed that the emissions from catalytic wood stoves increases 1 percent per year, and that catalysts were replaced every 5 years. However, the July 1989 revision to AP-42 section 1.10 (Residential Wood Stoves) notes that Phase II units are subject to a 10-30 percent degradation within the first 3 years of use.

The following step wise approach illustrates how the compiled survey data should be used to calculate RWC device emissions. This calculation procedures assumes that the following information is available from the household survey or other sources:

- Species of trees used for wood fuel;
- Quantity of each species combusted in RWC devices (in cords);
- Total amount of wood combusted in the community (in cords); and
- Number of RWC devices in the community, by device type (e.g., fireplaces, pellet stoves, certified catalytic stoves).

This calculation also assumes that information is available on emission factors for different RWC devices (see reference 17) and average heating degree days for specific locations (see references 14 and 15).

Step 1: Identify typical wood characteristics for your area

The first step in estimating emissions of particulate matter from RWC devices is to determine the types of fuel wood used for heating in your locality and the characteristics of the various wood species that affect particulate matter formation. Table A-1 lists several species of trees that are frequently used in the western and northwestern regions of the nation for fuel wood. Similar information on other species can be obtained from the USDA's publication "Wood Handbook." The density of the fuel wood species is the most important characteristic that should be identified. The densities of several species of trees are listed on Table A-1, and are used in Step 2 of the emissions estimation procedure to derive the quantity of each species combusted on a dry basis.

The energy content of the various wood species listed on Table A-1 is not used in the procedure described here, but could be used to derive the amount of wood it would be necessary to burn to achieve a certain heating level. If, for instance, an agency decided to base its estimates on the amount of heat necessary to heat a typical residence for a season (rather than on the amount of wood burned as indicated by the survey), the energy content of the wood could be used to determine the quantity of each species combusted if the percentage of each species fired could be determined.

Step 2: Determine the quantity of wood combusted on a dry basis

Once the density of the tree species used for fuel wood in the area is identified, the total quantity of wood combusted can be determined, as illustrated in Table A-2. For each of the major wood species used for fuel wood, an estimate of the number of cords consumed during the heating season is

TABLE A-1. CHARACTERISTICS OF VARIOUS WOOD SPECIES

Species	Energy Content (10^6 Btu/cord)	Density lbs/cubic foot (dry basis)
Aspen	16.5	21.4
White Oak	29.1	37.8
Cedar		
Alaska	18.9	24.5
Western Red	13.7	17.8
Douglas Fir		
Coast	20.6	26.7
Interior West	21.4	27.8
Interior North	20.6	26.7
Interior South	19.7	25.6
Larch, Western	22.3	28.9
Pine, Ponderosa	17.1	22.3
Spruce (Black, White and Sitka)	17.1	22.3

Source: Wood Handbook, Agricultural Handbook No. 72, U.S. Department of Agriculture, 1974. Washington, D.C.

TABLE A-2. DETERMINING QUANTITY OF FUEL COMBUSTED

Wood Fuel Type	Number of Cords Consumed Annually	Wood Density (lbs/ft^3 dry mass)	Assumed Solid Wood/Cord* (ft^3/cord)	Dry Wood Per Cord (lbs/cord)	Dry Wood/Cord (kg/cord)
White Oak	400,000	37.8	80	3,024	1,371
Western Douglas Fir	150,000	27.8	80	2,224	1,009
TOTAL	**550,000**				

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*Note that a standard cord is 128 ft^3 including wood and void spaces. This assumption is that approximately 80 ft^3 of that is solid wood.

determined from the survey data. Based on the density figures in Table A-1 and an assumption that each cord of wood contains roughly 80 cubic feet of solid wood, the quantity of solid wood of each species fired in a year can be determined. From this result, an estimate can be made of the dry mass of wood contained in a cord of each species. An example of this calculation for white oak, based on Table A-2, would be as follows:

$$\frac{37.8 \text{ lb dry white oak}}{\text{ft}^3} \times \frac{80 \text{ ft}^3}{\text{cord}} = \frac{3{,}024 \text{ dry lb}}{\text{cord}} \times \frac{0.4535 \text{ kg}}{\text{lb}} = \frac{1{,}371 \text{ dry kg}}{\text{cord}}$$

Based on the dry mass of wood of per cord of each species combusted and on the total amount of each species combusted (as determined from the survey data, a typical mass value for each cord of wood combusted in the locality can be determined by weighing the individual mass per cord values by the relative amount of each wood type combusted, using the following general equation:

$$MPCw = \frac{\sum_{i=1}^{n} (MPC_i \times C_i)}{\sum_{i=1}^{n} (C_i)}$$

where:

MPC_w = weighted average mass per cord, dry kg/cord

MPC_i = mass per cord for fuel species "i", dry kg/cord

C_i = annual consumption of species "i", cords/year

n = number of different wood types.

As applied to the information in Table A-2, this calculation would take the following form:

$$MPC_w = \frac{\left(\frac{1{,}371 \text{ kg oak}}{\text{cord}} \times 400{,}000 \text{ cords}\right) + \left(\frac{1{,}009 \text{ kg fir}}{\text{cord}} \times 150{,}000 \text{ cords}\right)}{400{,}000 \text{ cords oak} + 150{,}000 \text{ cords fir}}$$

MPC_w = 1,272 kg/cord

Step 3: Identify the mass of wood burned by appliance type

The mass of dry wood combusted by each type of wood combustion appliance in the locality can be estimated based on the survey data on the number of cords of fuel wood combusted in the community in each type of appliance. This estimation is based on the average mass of dry wood calculated in Step 2, as in the example in Table A-3.

In some instances, the information supplied by the household survey may not adequately delineate wood consumption by stove type (e.g., conventional, noncatalytic certified, and catalytic certified), or the reliability of this data may questioned because of a small sample size or data quality problems. Under these circumstances, this information may be estimated using the approach outlined below.

This alternative approach involves apportioning wood consumption based on the relative thermal efficiencies of the different appliance types. The overall thermal efficiency of conventional, noncatalytic certified, and catalytic stoves, is estimated to be 52%, 63% and 72%, respectively. For a given heat demand, efficient stoves consume less wood than inefficient ones. Therefore, if total wood consumption and the mix of appliance types are the only variables known, the amount of wood consumed by each appliance type can be calculated by solving for D, using the following equations:

$$TWC = (A * D) + (B * D * 0.84) + (C * D * .72)$$

Rearranging this formula gives:

$$D = TWC / [A + (B * 0.84) + (C * 0.72)]$$

where:

TWC = Total wood combusted in stoves, dry kg (from survey)
A = Number of conventional stoves, (from survey)
B = Number of certified noncatalytic stoves (from survey)

TABLE A-3. ESTIMATION OF WOOD BURNED BY APPLIANCE TYPE

Appliance Type	Wood Combusted by Appliance (cords/year)	Mass of Dry Wood (kg/cord)	Wood Burned by Appliance Type (kg)
Fireplace	165,000	1,272	2.1×10^8
Conventional Stove	247,500	1,272	3.1×10^8
PHASE II CERTIFIED STOVE			
Non-Catalytic,	27,500	1,272	3.5×10^7
Catalytic	27,500	1,272	3.5×10^7
Furnace	82,500	1,272	1.0×10^8

C = Number of certified catalytic stoves (from survey)

D = Wood consumption in a conventional stove, dry kg

0.84 = Relative heating efficiency for certified noncatalytic stove (i.e., kg of wood required for certified noncatalytic stove to produce the same quantity of heat as 1 kg burned in conventional stove)

0.72 = Relative heating efficiency for certified catalytic stove (i.e., kg of wood required for certified catalytic stove to produce the same quantity of heat as 1 kg burned in conventional stove

Finally, the amount of wood consumed by each appliance category is calculated using the following equations:

$E = D * A$

$F = D * 0.84 * B$

$G = D * 0.72 * C$

where:

E = wood consumed by conventional RWC devices, kg

F = wood consumed by certified non catalytic RWC devices, kg

G = wood consumed by certified catalytic RWC devices, kg

The following is an example of this approach. It assumes the following data on total wood combustion (TWC) and on the mix of RWC devices was gathered through the use of a survey.

TWC = 380,000,000 kg

A = 107,500 conventional stoves

B = 5000 certified non catalytic stoves

C = 6000 certified catalytic stoves

D = Wood consumption in an individual conventional stove

To solve for D, the following equation is constructed from this data:

380,000,000 = (107,500*D) + (5000*D) + (6000*D)

Rearranging this equation to solve for D yields the following:

D = 380,000,000/[107,500 + (5000*0.84) + (6000*.72)]
D = 380,000,000/[116,020]
D = 3275 kg of wood consumed in each conventional stove

The quantity of wood consumed in the population of conventional stoves, then, would be calculated as:

E =3275 kg/stove * 107,500 stoves = 352,062,500 kg

The quantity of wood consumed in the population of certified noncatalytic stoves would be calculated as:

F =3275 kg/stove* 0.84 efficiency factor * 5000 stoves = 13,755,000 kg

The quantity of wood consumed in the population of certified catalytic stoves would be calculated as:

G =3275 kg/stove * 0.72 efficiency factor * 6000 stoves = 14,148,000 kg

Step 4: Apply emission factors to calculate total annual PM-10 emissions

To calculate total PM-10 emissions from the RWC devices in a locality, the mass of wood burned by each appliance type (as calculated in Step 3) is multiplied by an emissions factor. These emission factors represent the average emissions of PM-10 from each type of appliance based on combustion of a certain amount of wood. Typical emission factors for different appliance types are listed in Table A-4. As noted in AP-42, they represent the field-operation emissions expected from wood heaters meeting the July 1, 1990 (Phase II) certification standards. These emission factors were developed for

TABLE A-4. EXCERPT FROM AP-42 SECTION 1.10 ON RESIDENTIAL WOOD COMBUSTION[a]

Appliance Type	PM-10 (g/dry Kg)	Efficiency[b]
Fireplace	14.0	[c]
Conventional Stove of Fireplace Insert	15.0[d]	52
PHASE II CERTIFIED STOVE		
Noncatalytic	9.6[d]	63
Catalytic	6.6[d]	72
Furnace	15.0[e]	[c]
Pellet Stove	1.6[d]	78

[a] See AP-42 for current version of section 1.10. Also, see discussion in text and in AP-42 on efficiency and performance degradation before using these factors.

[b] Overall efficiency represents sum of combustion and transfer efficiencies, and values represent averages of laboratory test resuts.

[c] No data provided in AP-42.

[d] Reference 18.

[e] Assume same emissions factors as conventional stoves.

inclusion in the AP-42, except as noted. The data for the noncatalytic and catalytic stoves are based on a limited data base of in-situ tests of stoves that were of average-or-better installation. It is anticipated that the quality of these stoves will improve, resulting in an improvement in their in-situ performance. As more in-situ data become available, the AP-42 values will be reviewed and revised, if appropriate. Refer to AP-42 to obtain any revisions to the factors in Table A-4 and for additional information on their derivation and use. The AP-42 emission factors should be used unless local conditions clearly show other emission factors would be more appropriate. For example, higher emissions might be anticipated if installation methods are particularly poor in a community or if a large number of stoves in the community do not meet the Phase II NSPS.

When these emission factors are multiplied by the quantity of wood consumed during the heating season by each RWC device type in the locality, the product is the quantity of PM-10 emitted from each appliance type per year. An example of the calculation of emissions from one appliance type (fireplace) would be as follows:

$$\frac{2.1 \times 10^{8}\ \text{kg wood}}{\text{year}} \times \frac{14\ \text{g PM}}{\text{kg}} \times \frac{\text{Mg}}{10^{6}\,\text{g}} = \frac{2.9 \times 10^{3}\ \ \text{Mg PM-10}}{\text{year}}$$

These products may then be aggregated for all appliance types to determine the total quantity of PM-10 emitted from all RWC devices in the locality. Table A-5 depicts an example of the calculation of emissions for a typical mix of RWC devices in a locality.

Step 5: Calculate average PM-10 emissions per heating degree day

To calculate the PM-10 emissions from residential wood combustion in a locality on the worst case "design day," the first step is to determine the average emissions per heating degree day. A heating degree day (HDD) is a measure of the number of degrees that the temperature in a residence must be raised over the outside temperature to maintain a temperature that is

TABLE A-5. EXAMPLE OF AGGREGATION OF EMISSIONS FOR APPLIANCE TYPE

Appliance Type	Annual Consumption (Kg/year)	PM-10 Emission Factor (g/kg)	PM-10 Emissions (Mg/year)
Fireplace	2.1×10^8	14.0	2.9×10^3
Conventional Stove or Fireplace Insert	3.1×10^8	15.0	4.6×10^3
PHASE II CERTIFIED STOVE			
Noncatalytic	3.5×10^7	9.6	3.4×10^2
Catalytic	3.5×10^7	6.6	2.3×10^2
Pellet Stove	1.0×10^8	1.6	1.6×10^2

TABLE A-6. NORMAL MONTHLY AND SEASONAL HEATING DEGREE DAYS, 65° BASE-SELECTED ROCKY MOUNTAIN/ WESTERN AND PACIFIC NORTHWESTERN CITIES

State	Station	JAN	FEB	MAR	APR	MAY	JUN	SEP	OCT	NOV	DEC
CA	Los Angeles	286	233	240	180	106	54	18	132	139	255
	Sacramento	611	412	366	229	83	21	7	82	360	601
	San Francisco	512	375	378	306	226	139	80	148	315	490
CO	Denver	1,101	879	837	528	253	74	135	414	789	1,004
NE	Omaha	1,017	773	756	558	333	124	171	456	767	1,172
OR	Portland	809	610	592	438	263	118	111	332	585	747
UT	Salt Lake City	1,128	865	753	474	220	53	97	377	759	1,076
WA	Seattle-Tacoma	803	622	645	459	313	169	169	388	606	744
	Spokane	1,218	913	849	576	339	140	209	539	903	1,116

comfortable to the residents (assumed to be 65°). The greater the number of heating degree days, the greater the quantity of wood combusted for heat and, consequently, the greater the quantity of emissions.

Average heating degree day requirements have been calculated for most areas of the country and are available through references (12,13). To calculate the average emissions per heating degree day, the average annual emissions are divided by the number of heating degree days in the heating season. In the example for fireplaces below, using heating degree day figures for Denver, Colorado drawn from Table A-6, it is assumed that the heating season includes all months when the number of heating degree days exceeds 100. Although in some cases there may be cold weather in other months, it is expected that these cold spells will be infrequent and relatively mild, so that burning wood for residential heat will not be significant.

$$\frac{\dfrac{2.0 \times 10^{3}\ \text{Mg PM-10}}{\text{year}}}{\dfrac{6{,}014\ \text{HDD}}{\text{heating season}}} = 0.33\ \text{Mg PM-10 per HDD during heating season}$$

Step 6: Calculate design day PM-10 emissions from wood combustion

To calculate design day PM-10 emissions from wood combustion, the average number of heating degree days per day during the months of the heating season associated with exceedances of the PM-10 NAAQS is calculated. This calculation is based on information such as that contained in Table A-6 and in references 14 and 15. This average number of HDD per month(s) when exceedances occur is then multiplied by the annual average PM-10 emissions per HDD, as calculated in Step 5.

$$\text{RWC emissions in exceedance months} = \frac{\text{Emissions (Mg Pm-10)}}{\text{Year}} \times \frac{\text{HDD in exceedance months}}{\text{HDD for entire year}}$$

When the emissions of PM-10 from RWC devices is calculated, the design day emissions is calculated as the average daily emissions during the exceedance months.

$$\text{Design day emissions} = \frac{\text{RWC emissions in exceedance months}}{\text{Total number of days in exceedance months}}$$

An example of this calculation for Denver would begin with an identification from agency records of the months in which exceedances of the PM-10 NAAQS generally occur (assumed for purposes of this example to be November, December, and January. If total PM-10 emissions from RWC devices for the year are estimated to be 2.0 X 10^3 Mg PM-10 and the heating degree days for these three months are 2894 (from Table A-6), emissions during this three-month period would be:

$$\frac{2.0 \times 10^3 \text{ Mg PM-10}}{\text{Year}} \times \frac{2894 \text{ HDD}}{6014 \text{ HDD}} = 962 \text{ Mg PM-10}$$

Based on there being 92 days during the three month period, the design day emissions of PM-10 for Denver in this example would be

$$\frac{962 \text{ Mg PM-10}}{92 \text{ days}} = 10.4 \text{ Mg/day}$$

Other methods for estimating the design day emissions may be considered. For example, the HDD for the actual exceedance days can be used (instead of the HDD in the exceedance months), provided monitoring occurred frequently enough to ensure that a representative estimate of the HDD on exceedance days can be obtained.

DATA EVALUATIONS AND QUALITY CHECKS

Survey data should be reviewed and evaluated for reasonableness and accuracy prior to calculating emissions. To accomplish this, local agencies should develop a quality assurance plan that outlines in detail specific steps planned to ensure high quality data. Such a plan and its execution serve to produce a more complete and accurate inventory while simultaneously promoting user and agency confidence in the data. The data/results generated under such a plan will allow a better assessment of control strategies and better resolution on the impact of RWC emissions on air quality.

As a general rule, the single piece of information most subject to error during an RWC survey is fuelwood consumption. Furthermore, fuelwood consumption is the single parameter that has the largest impact on calculated RWC emissions. For these reasons, data evaluations and quality checks should focus heavily on ensuring the accuracy of these values.

Errors associated with fuelwood consumption values described in the survey are due to judgment error by respondents. This generally results because respondents are unfamiliar with precise definitions for measuring fuelwood (i.e., standard cord, face cord, etc.). These judgment errors include both underestimates and overestimates of the quantity of fuel wood consumed. Several generalizations determined during a nationwide fuelwood survey performed by the U.S. Department of Agriculture may be useful in evaluating the responses. (Reference A-1) As a rule of thumb, respondents overestimated fuelwood consumption in fireplaces by approximately 20 percent. Similarly, those respondents claiming to burn over 10 cords of wood per year (in any wood burning device) were determined through follow-up surveys to have overestimated consumption by an average of about 45 percent.

Quality assurance checks should evaluate fuel consumption estimates in view of appliance type and use category (primary, secondary heat, occasional use, etc.). The data should be evaluated to identify apparent outliers. For perspective, Table A-7 presents 1980-1987 national estimates of total wood consumption by appliance type and average per unit consumption by appliance type. Table A-8 presents fuelwood consumption characteristics by timber region.

Apparent data outliers should be identified and follow-up contacts made. During subsequent interviews, respondents should be allowed and encouraged to

TABLE A-7. ANNUAL FUELWOOD CONSUMPTION IN THE USA BY APPLIANCE TYPE (1980 - 1987 Averages)

Appliance Type	Consumption of Wood By Appliance Type (10^6 Cords/Yr)	Average Amount of Wood Burned by Appliance Type Per Unit Bases (Cords/Appliance/Yr)
Ordinary Fireplace	9.8	0.8
Non-Airtight Stove	2.7	1.8
Fireplace Insert	9.5	2.3
Airtight Stove	15.5	2.8
Furnace	2.9	3.7

Source: Skog & Watterson, U.S. Department of Agriculture, p. 20.

TABLE A-8. FUELWOOD CONSUMPTION CHARACTERISTICS BY TIMBER REGION, 1980-81

	Characteristic				
		Percent of Households burning		Fuelwood Consumption	
Timber Region	Total Number of Households in Region	Any Amount	1/3 cord or more	Households Burning Any Amount	Households Burning 1/3 Cord or More
		Millions		--	Million Cords --
Northwest	2.5	55*	47*	3.2	3.2**
North Rocky Mountains	0.8	42*	34**	0.8**	0.8**
South Rocky Mountains	11.8	29*	16**	3.1**	2.8**
WEST	15.1	34*	22*	7.1*	6.8*

* Relative standard error is 10 pct or less.

**Relative standard error is 10.1-15 pct.

Source: Skog & Watterson.

describe fuelwood consumption in terms that are familiar to them. Surveyors should use the information in the responses to estimate revised consumption if necessary. Table A-9 lists guidelines for assisting surveyors in evaluating these follow-up responses.

TABLE A-9. GUIDELINES FOR ASSISTING SURVEYORS IN EVALUATING FUELWOOD CONSUMPTION RESPONSES (REF A-1)

Commonly Used Fuelwood Measurements	Estimated Relationship to a Standard Cord
Half-ton pickup truck full	0.500
Three-quarter ton pickup truck full	0.500
Small pickup truck full (Datsun, Toyota, LUV, etc.)	0.333
Full-size car trunk full	0.167
Small-size car trunk full	0.100
Full-size station wagon full	0.250
Small-size station wagon full	0.167
Suburban (carry all) full	0.500
Small lift-back (Citation, Corolla, etc.)	0.125
Tons: dry	0.667
Tons: wet	0.500
12-inch face cord	0.250
16-inch face cord	0.333
18-inch face cord	0.375
24-inch face cord	0.500
Standard Cord	1.000

Source: Skog and Watterson.

SUGGESTED REFERENCES FOR ADDITIONAL INFORMATION

Fuel Use Surveys

1. Elrick and Lavidge, Inc. The Pacific Northwest Residential Energy Survey, Volumes 1-12. Prepared for the Bonneville Power Administration and the Pacific Northwest Utilities Conference Committee under Contract No. DE-AC79-79BP13061. Portland, Oregon: Bonneville Power Administration. July 1980.

2. Michigan Department of Natural Resources. Fuelwood Consumption Survey in 1980. 1980.

3. Minnesota Department of Natural Resources. Firewood Use in Minnesota. Unpublished. 1980.

4. Puget Sound Power and Light Company, Rate Department. Residential Wood Heating Survey. Bellevue, Washington: Puget Sound Power and Light Company. July 1980.

5. U.S. Department of Agriculture, Pacific Northwest Forest and Range Experiment Station. Wood for Energy in the Pacific Northwest: An Overview. Portland, Oregon: U.S. Department of Agriculture. 1979.

6. U.S. Department of Agriculture Forest Service, Forest Products Laboratory. Survey Completion Report. Residential Fuelwood use in the United States: 1980-1981. Kenneth Skog and Irene Watterson July 1983.

7. U.S. Department of Energy, Energy Information Administration, Office of Coal, Nuclear, Electricity and Alternate Fuels. Estimates of U.S. Wood Energy Consumption From 1949 to 1981, Washington, DC 20585, August 1982.

General

8. Gay, Larry. *The Complete Book of Heating With Wood*. Charlotte, Vermont: Garden Way Publishing. 1974.

9. Monsanto Research Corporation. *Source Assessment: Residential Combustion of Wood*. Prepared for the U.S. Environmental Protection Agency under Contract No. 68-02-1874. Research Triangle Park, North Carolina: U.S. Environmental Protection Agency. March 1980. EPA-600/2-80-042b.

10. Shelton, Jay W. Jay Shelton's *Solid Fuels Encyclopedia*. Charlotte, Vermont. Garden Way Publishing. 1983.

11. U.S. Environmental Protection Agency (OAQPS). "Source Sampling Residential Fireplaces for Emission Factor Development" EPA-450/3-76-010, Contract no. 68-02-1992, November 1975.

12. U.S. Environmental Protection Agency. "Preliminary Characteristics of Emissions from Wood-Fired Residential Combustion Equipment," EPA-600/7-80-040, March 1980.

Fuel Wood Properties

13. U.S. Department of Agriculture, Forest Products Laboratory, *Wood Handbook*, Agricultural Handbook No. 72, Washington, DC. 1974.

Heating Degree Data

14. National Oceanic and Atmospheric Administration. *Historical Climatology*, Series No. S-1, July 1931 - June 1980. Asheville, North Carolina: National Climatic Center. 1981.

15. U.S. National Oceanic and Atmospheric Administration, "Climatography of the United States, No. 81," September 1982.

Survey Methods

16. Dillman, Don. Mail and Telephone Surveys: The Total Design Method. New York, New York: John Wiley. 1978.

Emission Factors

17. U.S. EPA (OAQPS). Compilation of Air Pollutant Emission Factors (AP-42), Third Edition, Supplement 14. RTP, NC, 1983.

18. U.S. EPA (OAQPS). "Residential Wood Stoves" Draft Supplement to Compilation of Air Pollutant Emission Factors (AP-42) Third Edition, RTP, NC, 1988.

ATTACHMENT TO APPENDIX A

Example of Cover Letter and Survey of Local Wood Heating Patterns

VICTOR ATIYEH
GOVERNOR

Department of Environmental Quality

522 S.W. FIFTH AVENUE, BOX 1760, PORTLAND, OREGON 97207 PHONE (503) 229-5696

May 3, 1985

Dear Resident:

The Department of Environmental Quality (DEQ) is conducting a survey to gather more information about home heating patterns and use of wood burning equipment of residents in the Medford area. The results of this survey will be used by the DEQ Air Quality Division for educational and planning purposes.

Your household is one of a small number in which people are being asked about home heating and wood burning. It was selected in a random sample of the entire area. So the results will be representative of the Medford area, it is important that each questionnaire be completed and returned. Information from individual households will be kept strictly confidential.

We ask that you fill out the enclosed questionnaire and return it to us on or before May 31, 1985. A self-addressed, prepaid envelope is enclosed for your convenience.

Your cooperation is appreciated. If you have any questions, please contact Marianne Fitzgerald at 229-5353, or call toll free, 1-800-452-4011. Thank you for your assistance.

Sincerely,

Fred Hansen
Director

MEF:n
AA3240

1985 MEDFORD AREA WOOD HEATING SURVEY

Please read the following questions carefully and circle, or write in the answer as indicated. Your cooperation is appreciated.

1. Your zipcode? (Please indicate in space below.)

____

2. Do you own or rent your home? (Please circle number of answer.)

    1. OWN
    2. RENT

3. What type of residence do you live in? (Circle number.)

    1. SINGLE FAMILY HOME
    2. APARTMENT OR DUPLEX
    3. CONDOMINIUM
    4. MOBILE HOME

4. How long have you lived at your present address? (Circle number.)

    1. LESS THAN 1 YEAR
    2. 1 TO 2 YEARS
    3. 2 TO 3 YEARS
    4. 3 TO 4 YEARS
    5. 5 YEARS OR MORE

5. Which of the following areas are insulated in your home? (Circle numbers of all answers that apply.)

    1. CEILINGS
    2. WALLS
    3. FLOORS
    4. STORM/THERMAL WINDOWS
    5. STORM DOORS
    6. WEATHER STRIPPING/CAULKING
    7 DON'T KNOW
    8. NONE

6. How many people live in your home? (Indicate in space below.)

______________ PEOPLE

7. What was your total household income in 1984, before taxes? (Circle number.)

    1. LESS THAN $10,000
    2. $10,000 TO $19,999
    3. $20,000 TO $29,999
    4. $30,000 TO $39,999
    5. $40,000 TO $49,999
    6. $50,000 OR MORE

1985 MEDFORD AREA WOOD HEATING SURVEY

8. Your present age is? (Circle number of answer.)

1. LESS THAN 25 YEARS OLD
2. 25-34 YEARS
3. 35-44 YEARS
4. 45-54 YEARS
5. 55-64 YEARS
6. 65 AND OLDER

9. Which of the following fuel types do you use to heat your home? (Please put the corresponding number in the appropriate space.)

MAIN SOURCE OF HEAT ________

SECONDARY SOURCE OF HEAT (IF ANY) ________

ADDITIONAL SOURCE OF HEAT (IF ANY) ________

1. NATURAL GAS
2. WOOD
3. ELECTRICITY
4. OIL
5. PROPANE
6. KEROSENE
7. SOLAR
8. TRASH/PAPER
9. OTHER ____________________

10. Do you burn wood in your residence? (Circle number.)

1. YES
2. NO

11. Have you installed a new or replacement woodstove or stove-like fireplace insert during the past year? (Circle number.)

NEW APPLIANCE	REPLACEMENT APPLIANCE
1. YES	1. YES
2. NO	2. NO

12. Have you installed a new woodstove or stove-like fireplace insert during the past two to five years? (Circle number.)

1. YES
2. NO

13. Do you plan to install any new or replacement woodburning equipment in the next two years? (Circle number.)

NEW EQUIPMENT	REPLACEMENT EQUIPMENT
1. DEFINITELY	1. DEFINITELY
2. MAYBE	2. MAYBE
3. NO	3. NO

If you plan to purchase a new or replacement woodstove, please refer to the list of informational brochures and publications available from DEQ on page 6.

1985 MEDFORD AREA WOOD HEATING SURVEY

IF YOU BURN WOOD, PLEASE ANSWER THE FOLLOWING QUESTIONS. IF NOT, PLEASE RETURN THE QUESTIONNAIRE IN THE RETURN ENVELOPE. THANK YOU FOR YOUR COOPERATION.

14. Do you burn wood primarily for: (Circle one number.)

    1. MAIN SOURCE OF HEAT?
    2. SUPPLEMENTAL SOURCE OF HEAT?
    3. ENJOYMENT?

15. How many cords of wood did you burn this heating season (October 1984 - April 1985)? A cord is a stacked pile 4 feet high, 4 feet deep, and 8 feet long. (Please indicate amount burned below.)

    ____________ CORDS

16. How much wood did you burn last heating season (1983-84) as compared to this heating season (1984-85)? (Circle number.)

    1. MORE
    2. SAME
    3. LESS
    4. NONE

17. How much wood do you expect to burn next heating season (1985-86) as compared to this heating season (1984-85)? (Circle number.)

    1. MORE
    2. SAME
    3. LESS
    4. NONE

18. Please mark the appropriate responses to the following questions.

Which of the following wood heating devices do you have? (Circle yes or no.)		How many devices do you have? (Write in number below.)	Age of each device? (Write in age below.)	Total number of cords burned per year in each device? (Indicate below.)
FIREPLACE (WITHOUT STOVELIKE INSERT)	YES NO	______	______ YEARS	______ CORDS
FIREPLACE (WITH STOVELIKE INSERT)	YES NO	______	______ YEARS	______ CORDS
WOODSTOVE	YES NO	______	______ YEARS	______ CORDS
WOOD BURNING FURNACE	YES NO	______	______ YEARS	______ CORDS
WOOD COOKSTOVE	YES NO	______	______ YEARS	______ CORDS

OTHER (PLEASE SPECIFY) ____

1985 MEDFORD AREA WOOD HEATING SURVEY

19. If you use a woodstove or fireplace insert, in which position is the intake air control set most of the time? (Circle number.)

    1. LOW (0 TO 1/3 OPEN)
    2. MEDIUM (1/3 TO 2/3 OPEN)
    3. HIGH (2/3 TO FULLY OPEN)

20. If you have a woodstove or fireplace insert, what kind of air intake control do you have? (Circle number.)

    1. AUTOMATIC
    2. MANUAL

21. What percent of the following type(s) of firewood do you burn most often? (Circle the numbers of all answers that apply and indicate approximate percent.)

		%
1.	FIR	________
2.	MADRONE	________
3.	OAK	________
4.	PINE	________
5.	MAPLE	________
6.	CEDAR	________
7.	LUMBER OR MILL SCRAPS	________________
8.	OTHERS (PLEASE SPECIFY)	________________

22. What are the four most frequent times you burn wood? (Please put corresponding number in the appropriate space below.)

    1. MIDNIGHT TO 6:00 A.M...WEEKDAYS
    2. 6:00 A.M. TO NOON......WEEKDAYS
    3. NOON TO 6:00 P.M...... WEEKDAYS
    4. 6:00 P.M. TO MIDNIGHT..WEEKDAYS
    5. ALL DAY................WEEKDAYS
    6. MIDNIGHT TO 6:00 A.M...WEEKENDS
    7. 6:00 A.M. TO NOON......WEEKENDS
    8. NOON TO 6:00 P.M.......WEEKENDS
    9. 6:00 P.M. TO MIDNIGHT..WEEKENDS
    10. ALL DAY................WEEKENDS

MOST FREQUENT TIME ________

SECOND MOST FREQUENT TIME ________

THIRD MOST FREQUENT TIME ________

FOURTH MOST FREQUENT TIME ________

23. If you have a woodstove or fireplace insert, approximately how many days did you burn this heating season (October 1984 - April 1985)? (Circle number.)

    1. UNDER 60 DAYS
    2. 60 - 99 DAYS
    3. 100 - 200 DAYS
    4. MORE THAN 200 DAYS

24. What was the average time (in hours) you burned during those days? Include any time there was a fire or burning coals in your stove. (Please indicate in space below.)

_________ HOURS PER DAY

25. Where do you obtain most of your firewood? (Circle the numbers of the answer that apply.)

1. PURCHASED FROM A DEALER
2. CUT ON PERSONAL PROPERTY
3. CUT ON PRIVATE LAND (OTHER THAN OWN)
4. CUT ON STATE FOREST LAND
5. CUT ON FEDERAL FOREST LAND
6. LUMBER OR MILL SCRAPS
7. RECEIVED FROM FRIENDS, NEIGHBORS, RELATIVES
8. OTHER (PLEASE SPECIFY) ______________________

26. If you purchased your firewood, what was the price you paid per cord?

_____________ DOLLARS PER CORD

27. If you cut your own firewood, what was the average round trip mileage to gather wood?

_____________ MILES

28. If you cut your own firewood, during which of the following seasons do you cut it? (Circle the numbers of the answers that apply.)

1. WINTER (DECEMBER, JANUARY, FEBRUARY)
2. SPRING (MARCH, APRIL, MAY)
3. SUMMER (JUNE, JULY, AUGUST)
4. FALL (SEPTEMBER, OCTOBER, NOVEMBER)

29. From the time of cutting to the time of burning, how long do you store your firewood before burning? (Circle the number that is most typical for you.)

1. 3 MONTHS OR LESS
2. 4-6 MONTHS
3. 7-12 MONTHS
4. 1-2 YEARS
5. MORE THAN 2 YEARS
6. DON'T KNOW

30. Where do you store most of your firewood? (Circle number.)

1. INSIDE HOME
2. GARAGE OR SHED
3. COVERED OUTSIDE
4. UNCOVERED OUTSIDE

31. Did you hear about the 20 day air stagnation advisory in Medford in January, 1985 (January 10 to January 29)? (Circle number.)

    1. YES
    2. NO
    3. DON'T REMEMBER

32. Did you discontinue woodburning as requested during this period? (Circle number.)

    1. YES
    2. NO
    3. DON'T REMEMBER

33. Is there anything else you would like to tell us about home heating and use of wood burning equipment? If so, please use this space for that purpose.

YOUR CONTRIBUTION TO THIS EFFORT IS GREATLY APPRECIATED. IF YOU WOULD LIKE A SUMMARY OF THE RESULTS, PLEASE CONTACT THE DEQ REGIONAL OFFICE IN MEDFORD AT 776-6010.

The following publications are available free from the Department of Environmental Quality, Public Affairs Section, P.O. Box 1760, Portland, Oregon 97207, or from any DEQ Regional office. Call Public Affairs at 229-5317 in the Portland area, or toll-free from other parts of the state at 1-800-452-4011.

_________ 1. Sizing Wood Stoves - How to match heating capacity to heating needs (1985 brochure).

_________ 2. Certified Woodstoves - Describes Oregon's woodstove certification program (1985 brochure).

_________ 3. List of DEQ Certified Woodstoves - (Current).

_________ 4. Catalytic Woodstoves - Describes this new type of woodstove (1985 brochure).

_________ 5. Burn Wood Better - Shows heat values and drying times for various types of wood; shows how to operate a stove to reduce emissions.

APPENDIX B

REPORT SPONSOR, AUTHORS, AND REVIEWERS

This report was produced under the direction of Thompson G. Pace, P.E., Senior Environmental Engineer, assisted by Martha Smith. Mr. Pace and Ms. Smith are with the USEPA's Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

The report was prepared by Radian Corporation (Austin, Texas, and Research Triangle Park, North Carolina) under contract to USEPA. Authors were Bob Davis (project director) and Gary Harrison (in the Austin office), and Barry Read in Radian's RTP office. Radian technical reviewers were Glenn Rives and Mike Hartman. A Technical Review Committee developed the recommended credits and made substantial improvements in early drafts of this document.

The names and affiliations of those who served on the Technical Review Committee appear below.

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Bob Lebens, EPA, Stationary Source Compliance Division, Washington, D.C.
Bob McCrillis, EPA, Office of Research and Development, RTP, NC
Dallas Safriet, EPA, Office of Air Quality Planning and Standards, RTP, NC
Martha Smith, EPA, Office of Air Quality Planning and Standards, RTP, NC
Jeff Telander, EPA, Office of Air Quality Planning and Standards, RTP, NC
John Watson, Desert Research Institute (Reno, NV)
Dale Wells, EPA, Region 8 (Denver)
Ann Williamson, EPA, Region 10 (Seattle)
Barry Young, California Air Resources Board, Sacramento, CA

APPENDIX C

EXAMPLE ORDINANCES

Jurisdiction	Illustrates
Aspen, Colorado (Item 1)	• Good use of rationale/justification for program (p. 1, only included)
Washoe County Nevada (Item 2)	• Definitions of appliances (pp. 1-2)
	• Inspection of retail outlets (p. 5)
	• Accelerated changeover (pp. 5-7)
	• Mandatory elimination of noncertified RWC devices (p. 7)
Butte, Montana (Item 3)	• Curtailment in general, and specifically: action points, monitoring, notification (pp. 5-6)
	• Exemptions to curtailment via permit system (pp. 7-9)
	• Expiration and renewal of permits (pp. 7-9)
Telluride, Colorado (Item 4)	• Local standards more stringent than prevailing state or federal standards (pp. 2-3)
	• Registration and permitting system for new and existing RWC devices (pp. 3-4)
	• Limits one RWC device per dwelling (p. 4)
	• Ban on coal use (p. 4)
	• Emission fee in $/gram for certified levels (p. 5)
	• Fireplaces restricted to certain public areas (p. 5)
	• Mandatory retrofit of fireplaces (p. 5)
	• Fuel quality specifications (p. 5)

Jurisdiction	Illustrates
Telluride, Colorado (continued)	• Rebates for conversion to alternative heating (p. 6)
	• Two for one offsets -- two permits for existing units must be retired for each new device installed (pp. 6-7)
	• Inspection and enforcement (p. 7)
	• Appeals procedures (p. 8)
Crested Butte, Colorado (Item 5)	• Installation requirements

Appendix C

Item 1

ASPEN, COLORADO

Note: Only first page of ordinance is provided. This illustrates a good justification section for a RWC emission control ordinance.

ORDINANCE NO. 20
(Series of 1988)

AN ORDINANCE AMENDING PORTIONS OF SECTION 11 ARTICLE II OF THE MUNICIPAL CODE OF THE CITY OF ASPEN, COLORADO, TO REGULATE AND REGISTER FIREPLACES AND SOLID FUEL BURNING DEVICES, REQUIRING FIREPLACES INSTALLED IN THE FUTURE TO CONTAIN AND BE USED ONLY WITH TECHNOLOGY WHICH MAKES THEM APPROVED CLEAN-BURNING DEVICES, PERMITTING FIREPLACES CONTAINING AND OPERATED WITH GAS LOGS TO BE CONSIDERED "CERTIFIED DEVICES", AND PRESCRIBING THE PENALTY FOR A VIOLATION OF SAID AMENDMENT

WHEREAS, the Aspen area has exceeded healthful levels of total particulates for most of the years from 1975 through 1987; and

WHEREAS, PM_{10} levels in Aspen have also been found to exceed healthful levels; and

WHEREAS, these levels of PM_{10} pollution also cause visibility degradation which is harmful to the quality of life of residents and visitors; and

WHEREAS, the Colorado Health Department has determined through numerous studies that woodburning is one of the two significant sources of PM_{10} pollution in Aspen, and is the main source of the toxic portion of PM_{10} pollution, and

WHEREAS, the Aspen area has measured three exceedances of the health standards for PM10 pollution, after less than one winter of monitoring; and

WHEREAS, the intent of this ordinance is to promote clean air and to encourage alternative technologies and approaches to improving air quality, and

WHEREAS, the City Council of the City of Aspen desires to provide financial assistance if possible to citizens unable to upgrade existing solid fuel burning devices to cleaner devices, and to do so needs to determine the number of such devices; and

WHEREAS, the City Council, for the purpose of protecting the health, safety and welfare of the residents and visitors of the City of Aspen, desires to amend portions of Section 11, Article II of the Municipal Code of the City of Aspen to regulate construction and use of fireplaces and other solid fuel burning devices.

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Appendix C

Item 2

WASHOE COUNTY, NEVADA

Note: Nine pages of excerpts from Washoe County illustrate:

- Definition of appliances (pp. 1-2)
- Inspection of retail outlets (p. 5)
- Accelerated changeover (p. 7)
- Episodic controls (pp. 8-9)

DISTRICT HEALTH DEPARTMENT

AIR POLLUTION CONTROL REGULATIONS PERTAINING TO WOOD STOVES

010.0255 **"CERTIFIED"** means a wood stove/fireplace insert has been certified in accordance with current standards adopted by the U.S. EPA, the State of Oregon, the State of Colorado an/or appears on the Washoe County District Health Department Official List of Certified Wood Stoves; Ref. 40 CFR, Part 60; Oregon Administrative Rules, Chapter 340, Division 21; Colorado Revised Statute, Regulation No. 4.

010.045 **"COOK STOVE"** means a wood stove installed in the kitchen which is primarily designed for cooking and has a stove top and an oven. It may also be equipped with gas burners. This wood stove is exempt from the emission standards and requirements of Sections 040.051 and 040.0512.

010.063 **"FIREPLACE"** means an open hearth or fire chamber or similar prepared place in which a fire may be made and which is built in conjunction with a chimney. It may have doors, provided they are not designed with gaskets, air intake controls or other modifications which create an air starved operating condition. Fireplaces without such modifications are exempt from the emission standards and requirements of Sections 040.051 and 040.0512.

010.117 **"PELLET BURNER"** means a solid fuel burning device designed to heat the interior of a building. It is a forced draft heater with an automatic feed which supplies appropriately sized feed material or compressed pellets of wood, coal or other biomass material to the firebox.

010.143 **"STOVE KIT"** means a kit that may include a door, legs, flue pipe and collars, brackets, bolts and other hardware and instructions for assembling the wood heater with ordinary tools. Wood heaters built from such kits must meet all emission standards and requirements of Sections 040.051 and 040.0512.

010.145 "UNCERTIFIED" means a wood stove/fireplace insert that cannot be verified as meeting the certified standards and/or does not appear on the Washoe County District Health Department Official List of Certified/Exempt Wood Stoves.

010.200 **"WOOD HEATER"** means an enclosed wood burning appliance capable of, and intended for space heating, domestic water heating or indoor cooking and has an air-to-fuel ratio of less than 35 to 1 in the low burn cycle. It also must have a usable firebox volume less than twenty (20) cubic feet, weigh less than 800 kilograms and have a minimum burn rate less than five (5) kilograms per hour.

Appliances that are described as prefabricated fireplaces and are designed to accommodate doors or other accessories that would create the air starved operating conditions of a wood heater, must meet the emission standards if they meet the criteria in the above definition with those accessories in place.

010.205 **"WOODSTOVE/FIREPLACE INSERT"** means for purposes of compliance with Sections 040.051 and 040.0512, a wood stove may be a wood heater, pellet stove, prefabricated zero clearance fireplace or a fireplace heat form with doors or other accessories which cause the fireplace to function as a wood heater. Wood stoves do not include open masonry fireplaces, barbeque devices, gas-fired fireplaces or cook stoves.

020.040 PENALTIES

A. Except as provided in Subsections B, C, and D, a violation of any section of these regulations constitutes a major violation.

B. Any person who violates any section of these regulations, other than Sections 020.050 and 020.055, is guilty of a civil offense and shall pay an administrative fine of not more than $5000.00. Each day of violation constitutes a separate offense.

C. Any violation of Sections 040.005(B), 040.030, 040.035, 040.040 (A), 040.045, 040.050, 040.051, 040.055, 040.080, and 050.015 of these regulations constitutes a minor violation unless the violation occurs on more than two (2) occasions during a period of twelve (12) consecutive months. In that event, the third (3rd) and any subsequent violations constitute major violations.

D. Any person who violates Sections 040.051 or 040.0512 shall pay an administrative fine up to $1000.00. Each day of violation constitutes a separate offense.

E. The following fines shall be levied for minor violations of these regulations:

	First Violation	Second Violation
Section 040.005 (B) (Wood Stove Opacity)	not less than 50 not more than 250	not less than 20 not more than 50
Section 040.030 (Dust Control)	not less than 100 not more than 250	not less than 30 not more than 50
Section 040.035 (Open Fires)	not less than 25 not more than 250	not less than 10 not more than 50
Subsection A of Section 040.040 (Fire Training)	not less than 50 not more than 250	not less than 20 not more than 50
Section 040.045 (Refuse Burning)	not less than 25 not more than 250	not less than 10 not more than 50
Section 040.050 (Incinerator Emission)	not less than 50 not more than 250	not less than 20 not more than 50
Section 040.051 (Certified Woodstoves)	not less than 100 not more than 250	not less than 30 not more than 50
Section 040.055 (Odors)	not less than 50 not more than 250	not less than 20 not more than 50
Section 040.080 (Gasoline Storage)	not less than 50 not more than 250	not less than 20 not more than 50
Section 050.015 (Emer. Episode)	not less than 100 not more than 250	not less than 20 not more than 50

040.005 VISIBLE AIR CONTAMINANTS

B. No person may permit emissions from a residential woodstove, fireplace insert or fireplace to exceed an opacity greater than that shade designated as No. 2 on the Ringelmann Chart for a period or periods aggregating more than three (3) minutes in any one hour period. Emissions created during a fifteen (15) minute start-up period are exempt.

1. A person who violates Subsection B shall be issued a warning for the first violation and shall be provided information on proper woodburning tecnniques.

040.051 WOODSTOVE/FIRE PLACE INSERT EMISSIONS

A. Emission Standard

Commencing November 1, 1987, it is unlawful for any person to advertise, except when restrictions are noted, sell, offer to sell, or install any woodstove/fireplace insert to any person for installation in any residence within the Health District if it emits more than fifteen (15) grams of particulate matter per hour for a non-catalytic appliance or six (6) grams of particulate matter per hour for a catalytic appliance. Commencing June 30, 1988, the standard shall be nine (9) grams of particulate matter per hour for a non-catalytic appliance and four (4) grams of particulate matter per hour for a catalytic appliance. If the U.S. Environmental Protection Agency adopts a woodstove/fireplace emission standard which is more stringent, that emission standard supercedes the standard in this Section and becomes effective on the date that the U.S. Environmental Protection Agency standard becomes effective.

B. Certification

A wood stove/fireplace insert shall be considered certified for purposes of these regulations as defined in Section 010.0255.

C. Enforcement

1. No local government authority within the Health District may issue a building permit to any person to install an uncertified woodstove/fire place insert on or after November 1, 1987.

2. The Control Officer shall on November 1, 1987, and periodically thereafter, inspect wholesale and retail outlets for woodstoves/fire place inserts to ascertain their compliance with this Section and shall make available to the public a list of all certified appliances by brand name and model being offered for sale within the Health District.

D. Dealers Report of Sale

1. Commencing November 1, 1987, every person who sells a woodstove/fireplace insert within the Health District must report the sale to the Control Officer within thirty (30) days from the end of each month on the form provided by the Control Officer.

2. The form shall be provided by the Control Officer after the person pays the fee established by the District Board of Health for that form.

3. Any person who fails to notify the Control Officer of the sale is subject to the penalties set forth in Section 020.040.

040.0512 EXISTING WOODSTOVE/FIREPLACE INSERT - REPLACEMENT

A. Commencing July 1, 1988, it is unlawful for any person to complete, or allow the completion of, any escrow transaction for the transfer or conveyance of any previously occupied residential real property unless the residential real property has been certified by the Control Officer as being in compliance with the woodstove/fireplace insert certification requirements of these regulations.

B. A person may be licensed by the Control Officer to inspect and certify that woodburning stoves/fireplace inserts in residential real properties are certified.

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C. To obtain a license, an application must be made to the Control Officer, on a form approved by the Control Officer, for that purpose. A license will be issued upon satisfactory completion of all requirements set forth by the Control Officer and payment of the fee established by the District Board of Health for the licensing process. A license remains in effect for one year from the date of issuance and may be renewed upon meeting all the requirements of the Control Officer and payment of the renewal fee.

D. A licensee shall report the result of each inspection of a residential real property on a form provided by the Control Officer after the licensee pays the fee established by the District Board of Health for that form. The licensee must indicate that:

1. No woodstove/fireplace insert exists within the residential real property; or

2. Each woodstove/fireplace insert within the residential real property is certified; or

3. Any of the woodstoves/fireplace inserts within the residential real property are uncertified.

E. Not later than seven (7) working days after receipt of a report from the licensee, the Control Officer will issue a Certificate of Compliance if each woodstove/fireplace insert is certified. If the Control Officer fails to act within the seven (7) day period, all woodstoves/fireplace inserts within the residential real property will be deemed certified.

F. If the report indicates that a woodstove/fireplace insert is uncertified, the woodstove/fireplace insert must be removed from the property, retrofitted to meet certification standards or replaced with a certified device. Reinspection from a licensee is required.

G. The Control Officer may issue a Certificate of Compliance for a residential real property if a person provides a copy of the Dealer's Report of Sale issued under Section 040.051 (E) and provides evidence that the certified woodstove/fireplace insert has been installed in compliance with all applicable building, fire and other codes adopted by the jurisdiction in which the residential real property is located.

H. If a residential real property is to be sold and does not contain a wood stove/fireplace insert, a form approved by the Control Officer, containing the notarized signatures of both the buyer and seller attesting to that fact, may be accepted in lieu of an inspection, and a Notice of Exemption may be issued. On any subsequent sale, a new Notice of Exemption or Certificate of Compliance is required.

I. A Certificate of Compliance issued pursuant to this Section:

1. Remains valid until such time as the residential real property is transferred or conveyed to a new owner.

2. Does not constitute a warranty or guarantee by the licensee or the Control Officer that the woodstove/fireplace insert within the residential real property meets any other standards of operation, efficiency or safety, except the emission standards contained in these regulations.

J. Commencing January 1, 1993, it is unlawful for any person to have a woodstove/fireplace insert in any residential real property unless:

1. The woodstove/fireplace insert is certified; or

2. The residential real property has received a Certificate of Compliance.

K. Any person who violates any of the requirements of this Section, or who falsely attests as to information as part of compliance with this Section, is subject to the penalties as set forth in Section 020.040 and may be subjected to the applicable penalties prescribed by law for perjury and may have any license issued by the Control Officer pursuant to this Section revoked.

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050.005 EPISODE CRITERIA LEVELS

TABLE 1

EPISODE CRITERIA LEVELS

POLLUTANT	AVERAGING TIME	STAGE 1 (ALERT) PSI 150	STAGE 2 (WARNING) PSI 300	STAGE 3 (EMERGENCY) PSI 400
Carbon Monoxide	8 Hour	12 ppm	30 ppm	40 ppm
Ozone	1 Hour	0.16 ppm	0.40 ppm	0.50 ppm
Particulates PM-10	24 Hour	250 ug/m3	420 ug/m3	500 ug/m3

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050.015 EPISODE CONTROL ACTIONS

The Control Officer and the appropriate law enforcement and public health officials shall take the following control actions upon declaration of the following stages:

A. Stage 1

1. A health warning for sensitive persons shall be included in all notifications given pursuant to Section 050.010.
2. All open burning must be terminated.
3. The use of permitted incinerators shall be terminated. Crematoriums or pathological incinerators may continue to operate if the Control Officer determines that cessation of operation will cause a greater health hazard.
4. A request shall be made to the public to curtail any unnecessary motor vehicle operations.
5. Whenever the measurements of particulates (PM-10) or carbon monoxide reach, or are predicted to reach Stage 1 levels and adverse meteorological conditions are predicted to persist, the burning of any solid fuel in commercial or residential stoves and/or fireplaces shall be suspended unless it can be demonstrated, in accordance with the procedures established by the Control Officer, that such fuels supply the only heat available to the person burning it. The suspension shall remain in effect until all episode stages have been terminated.
6. Sources covered under Section 050.030 must commence curtailment of operations as per their submitted and approved plans.

Appendix C

Item 3

BUTTE, MONTANA

Note: Illustrates:

- Curtailment provisions (pp. 5-6)
- Exemptions to curtailment via permit system (pp. 7-9)

COUNCIL BILL NO. 330

ORDINANCE NO. 330

AN ORDINANCE REDUCING THE LEVEL OF AIR POLLUTANTS AT OR BELOW THOSE STANDARDS FOUND IN ADMINISTRATIVE RULES OF MONTANA, TITLE 16, CHAPTER 8 SUB-CHAPTER 8 AND 9, AND IN EFFECT AS OF OCTOBER 15, 1985; PROVIDING FOR AUTHORITY; PROVIDING FOR INTENT; PROVIDING FOR SCOPE; PROVIDING FOR DEFINITION AND TERMS; ESTABLISHING REGULATIONS; PROVIDING FOR PERMITS; PROVIDING FOR ENFORCEMENT; PROVIDING FOR PENALTIES; PROVIDING FOR SEVERABILITY; PROVIDING FOR THE REPEAL OF ANY ORDINANCE OR RESOLUTION IN CONFLICT HEREWITH; AND PROVIDING FOR AN EFFECTIVE DATE HEREIN.

BE IT ORDAINED BY THE COUNCIL OF COMMISSIONERS OF THE CITY AND COUNTY OF BUTTE-SILVER BOW, STATE OF MONTANA:

SECTION 1: AUTHORITY: The authority to promulgate this Ordinance is provided for in Ordinance 68 of the City and County of Butte-Silver Bow.

SECTION 2: INTENT: This Ordinance is necessary to preserve, protect, improve, achieve and maintain such levels of air quality as will protect the health and welfare of citizens of the City and County of Butte-Silver Bow.

SECTION 3: SCOPE: This Ordinance applies to all persons, agencies, institutions, businesses, industries or government entities living in or located within the area defined in the attached District Map and legal description. Stationary sources with the potential to emit more than 25 tons per year of any pollutant, with the exception of five (5) tons per year of lead, regulated under the Montana Clean Air Act, are not subject to this Ordinance.

SECTION 4: DEFINITIONS: For the purpose of this Ordinance the following definitions shall apply:

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(A) "Air Contaminant" means dust, ash, fumes, gas, mist, smoke, vapor, odor, or any particulate matter or a combination thereof present in the outdoor atmosphere.

(B) "Air Pollution Control District" means the geographical area designated as such by the map and legal description attached hereto and by this reference made a part hereof.

(C) "Board" means the Butte-Silver Bow Board of Health defined by Ordinance 68.

(D) "Class I Permit" means an emission permit issued by the Government to operate a residential solid fuel burning device during an Air Pollution Alert.

(E) "EPA Method" means 40 CFR Part 60, Subpart AAA, Sections 60.531, 60.534, and 60.535.

(F) "Emission" means a release into the outdoor atmosphere of an air contaminant.

(G) "Government" means the local government of Butte-Silver Bow.

(H) "Opacity" means a measurement of visible emissions defined as the degree expressed in percent to which emissions reduce the transmission of light and obscure the view of an object in the background. Opacity shall be determined only by Government personnel who have successfully completed the Montana Department of Health and Environmental Sciences Visual Emissions Evaluation Course and hold a current qualification.

(I) "Oregon Method" means Oregon Department of Environmental Quality "Standard Method for Measuring the Emissions and Efficiencies of Woodstoves", Sections I through 8 and O.A.R. Chapter 340. Division 21 Sections 100, 130, 140, 145, 160, 161, 163, 164, 165.

(J) "Residential Solid Fuel Burning Device" means any fireplace, fireplace insert, wood stove, wood burning heater, wood fired boiler, coal-fired furnace, coal stove, or similar device burning any solid fuel used for aesthetic, cooking, or heating purposes, which burns less than 1,000,000 B.T.U.'s per hour.

(K) "Sole Source of Heat" means one or more residential solid fuel burning devices which constitute the only source of heat in a private residence for purpose of space heating. No residential solid fuel burner or burners shall be considered to be the sole source of heat if the private residence is equipped with a permanently installed furnace or heating system, designed to heat the residence connected or disconnected from its energy source, utilizing oil, natural gas, electricity, or propane. A sole source permit may be issued by the government when the heating system is only minimally sufficient to keep the plumbing from freezing. Only residences equipped with a residential solid fuel burning device which qualifies for a Class I Permit may obtain a new Sole Source of Heat Permit after July 1, 1988.

(L) "Special Need" means a person who demonstrates an economic need to burn solid fuel for residential space heating purposes by qualifying

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for energy assistance according to economic guidelines established by the U.S. Office of Management and Budget under the Low Income Energy Assistance Program "L.I.E.A.P." as administered in the City and County of Butte-Silver Bow by the District 12 Human Resource Development Council.

(M) "Particulate Matter" Ten (PM-10) means particulate matter up to a nominal size of 10 micrometers.

SECTION 5: REGULATIONS:

(A) Solid Fuel Burning Devices

1. Within the air pollution control district, no person owning or operating a residential solid fuel burning device shall cause, allow, or discharge emissions from such device which are of an opacity greater than twenty five (25) percent.

2. The provisions of this subsection shall not apply to emissions during the building of a new fire, for a period or periods aggregating no more than thirty (30) minutes in any four (4) hour period.

3. Within the Air Pollution Control District, no person in control of a residential solid fuel burning device shall emit any visible emission from such device during an Air Pollution Alert declared by the Government unless a Sole Source of Heat, Special Need Permit, Class I Permit or a Temporary Sole Source of Heat Permit has been issued for such device.

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4. Within the Air Pollution Control District, no person in control of a residential solid fuel burning device for which a Sole Source of Heat, special need or Class I Permit has been issued shall cause, allow or discharge any emissions from such device which are of an opacity greater than ten (10) percent during an Air Pollution Alert declared by the Government. The provisions of this paragraph shall not apply to emissions during the building of a new five or for refueling for a period or periods aggregating no more than thirty (30) minutes in any four (4) hour period.

5. For the purpose of this section, the Government may declare an Air Pollution Alert to be in effect whenever the ambient concentration of (PM-10) within the Air Pollution Control District equals or exceeds 100 micrograms per cubic meter (ug/m^3) averaged over any four (4) hour period and when scientific and meterological data indicate the average (PM-10) concentrations will remain at 100 ug/m^3 if an Air Pollution Alert is not called. The Government may call an Air Pollution Alert whenever available scientific and meterological data indicate that the ambient concentration of (PM-10) within the Air Pollution Control District can reasonably be expected to equal or exceed 100 ug/m^3 averaged over a four (4) hour period

within the next twenty four (24) hours. As a surrogate method for (PM-10) measurement, the Government may use nephelometer readings correlated to ambient (PM-10) concentrations.

6. The Government has a duty, when declaring an Air Pollution Alert to be in effect, to take reasonable steps to publicize that information and to make it reasonably available to the public at least three (3) hours before initiating any enforcement action for a violation of this subsection.

7. Every person operating or in control of a residential solid fuel burning device within the Air Pollution Control District has a duty to know when an air pollution alert has been declared by the Government.

B. Solid Fuel

1. Within the Air Pollution Control District no person shall burn any material in a residential solid fuel burning device except black and white newspaper, untreated wood and lumber, and products manufactured for the sole purpose of use as fuel. Products manufactured or processed for use as fuel must conform to other applicable sections of this program

2. The use of coal as a fuel in a residential solid fuel burning device is prohibited within the Air Pollution Control District.

C. Liquid Fuel

1. It shall be a violation of this Ordinance

to allow diesel fuel burning vehicles or locomotives to idle over a period exceeding one (1) hour during an Air Pollution Alert.

SECTION 6: **PERMIT:**

(A) Class I Permits

1. The Government may issue a Class I Permit for solid fuel burning devices if the emissions do not exceed 3.0 grams per hour weighted average when tested in conformance with the Oregon Method or 4.1 grams per hour weighted average when tested using the EPA Method.

2. Class I permits issued for solid fuel burning device which may be operated during an Air Pollution Alert shall be valid for a period of two (2) years for any solid fuel burning device. They shall not be transferable from person to person or from place to place unless reissued by the Government. After a Class I Permit expires, the Government shall require information to determine if the solid fuel burning device is capable of meeting emission requirements before issuing another permit.

(B) Sole Source Heat Permit

1. Within the Air Pollution Control District, no personal in control of a residential solid fuel burning device which is a Sole Source of Heat shall cause, allow, or discharge any emissions from such device which are of a opacity greater than ten (10)

percent during an Air Pollution Alert called by the Government unless a source of heat permit has been issued for a residential solid fuel burning device by the Government. Sole Source Heat Permits shall be valid for one (1) year.

(C) Temporary Sole Source of Heat Permit

1. In an emergency situation the Government may issue a Temporary Sole Source of Heat Permit. An emergency situation shall include but is not limited to a situation where a person demonstrates that his furnace or central heating system is inoperable other than through his own actions or the situation where the furnace or central heating system is involuntarily disconnected from its energy source by a public utility or other fuel supplier. The term of the Temporary Sole Source of Heat Permit is at the discretion of the Government based on need.

(D) Special Needs Permit

1. A person who demonstrates an economic need to burn solid fuel for residential space heating purposes by qualifying for energy assistance according to economic guidelines established by the U.S. Office of Management and Budget under the Low Income Energy Assistance Program (L.I.E.A.P.) as administered in the City and County of Butte-Silver Bow by the District 12 Human Resource Development Council, is eligible for a Special

Need Permit which shall be issued by the Government.

2. Application for a special need permit may be made to the Government at any time, and a special need permit shall be valid for a period of not more than one (1) year from the date it is issued. Special Need Permits may be renewed providing the applicant meets the applicable need and economic guidelines at the time of application for renewal. Special Need Permits shall be issued at no cost to the applicant. A Special Need Permit is not transferable from place to place and is not transferable to a person other than the person to whom it is issued.

SECTION 7: **ENFORCEMENT:**

1. The provisions of this Ordinance shall be enforced by the Butte-Silver Bow Health Department health authorities or the appropriate law enforcement officials.

2. Sole Source of Heat Permits, Special Need Permits, Class I Permits and Temporary Sole Source of Heat Permits for residential solid fuel burning devices can be issued, denied, suspended and revoked.

SECTION 8: **PENALTIES:** The minimum schedule of penalties for violations of this Ordinance is as follows:

(A) First Violation - Twenty five dollars ($25.00)

(B) Second Violation - Fifty dollars ($50.00)

(C) Third or Subsequent Violation - One hundred

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dollars ($100.00)

(D) No person or entity shall be cited for a violation of this Ordinance more than once in any Calendar Day. However, each Calendar Day of violation may be considered a separate offense.

(E) For the purpose of Section 9, only those violations of the Ordinance by a person or entity which have occurred with one (1) year of a present offense shall be considered as prior violations

(F) Violation of this Ordinance shall be considered a MISDEMEANOR punishable by a fine not to exceed $500.00 and imprisonment in the county jail for a term not to exceed six (6) months, or by both a fine and imprisonment.

(G) Jurisdiction shall be in the Police Court of Butte-Silver Bow.

SECTION 9: SEVERABILITY: If any provision of this Ordinance, or any section thereof, in any circumstances is held invalid, the validity of the remainder of the Ordinance and of the application of any of the other provisions or sections shall not be affected.

SECTION 10: REPEALER: All ordinances and resolutions in conflict herewith are repealed.

SECTION 11: EFFECTIVE DATE: This Ordinance shall be in full force and effect from and after thirty days after its passage and approval.

PASSED this 3rd day of AUGUST, 1988.

David A Fisher Sr

CHAIRMAN OF THE COUNCIL OF COMMISSIONERS

APPROVED THIS 3rd day of AUGUST, 1986.

CHIEF EXECUTIVE

ATTEST:

CLERK AND RECORDER

APPROVED AS TO FORM:

COUNTY ATTORNEY

CHAIRMAN OF THE JUDICIARY COMMITTEE

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Appendix C

Item 4

TELLURIDE, COLORADO

Note: Illustrates:

- Local standards more stringent than prevailing state or federal standards (pp. 2-3)
- Registration and permitting system for new and existing RWC devices (pp. 3-4)
- Limits one RWC device per dwelling (p. 4)
- Ban on coal use (p. 4)
- Emission fee in $/gram for certified levels (p. 5)
- Fireplaces restricted to certain public areas (p. 5)
- Mandatory retrofit of fireplaces (p. 5)
- Fuel quality specifications (p. 5)
- Rebates for conversion to alternative heating (p. 6)
- Two for one offsets -- two permits for existing units must be retired for each new device installed (pp. 6-7)
- Inspection and enforcement (p. 7)
- Appeals procedures (p. 8)

Chapter 8.12

SOLID FUEL BURNERS

Sections:

8.12.010 Definitions
8.12.020 Standards for Regulation of Solid Fuel Burning Devices
8.12.030 Administration
8.12.040 General Rules and Regulations
8.12.050 Abatement
8.12.060 Number of Permits
8.12.070 Investigation and Noncompliance
8.12.080 Appeals to Board of Adjustment
8.12.090 Penalties
8.12.100 Colorado Department of Health

8.12.010 Definitions

A. For the purposes of this Chapter, unless otherwise apparent from the context, certain words and phrases used in this Chapter are defined as follows:

1. "Appendix A" and "Appendix B" means the test procedures promulgated by the State Department of Health as described in Colorado Air Pollution Regulation No. 4, in effect as of August 15, 1985. See Exhibit A incorporated in this Chapter by reference.

2. "Commission" means the duly- constituted Town Enviromental Commission.

3. "Department" means the Town Building Department.

4. "Person" means any individual, public or private corporation, partnership, association, firm, trust, estate or any other legal entity whatsoever which is recognized by law as the subject of rights and duties.

5. "Solid fuel burning device" means any device, including, but not limited to, fireplaces or wood stoves of any nature, as defined in C.R.S. 25-7-402, or any other device used for the

purpose of burning combustible material. This definition specifically excludes barbeque devices or any other authorized burning device used in Town-sponsored activities.

6. "Structure" means anything constructed or erected, which requires location on the ground and is a combination of roof and supporting walls and/or columns.

7. "Unit" means an individual space consisting of enclosed rooms occupying all or part of one or more floors of a structure.

B. Any word, term or phrase not defined or specified in this Chapter shall be defined in accordance with the Telluride Land Use Code, as amended.

8.12.020 Standards for Regulation of Solid Fuel Burning Devices

A. After the effective date for registration as set forth in section 8.12.030, no solid fuel burning device permit shall be issued unless said device has been certified by the State of Colorado, Department of Health, and has an emission rate calculated as per Colorado Air Pollution Regulation No. 4, Section IV.A., which meets the following standards:

1. The solid fuel burning device shall emit particulates at a rate of six (6) grams per hour or less when tested in accord with Appendix A or four (4) grams per hour or less when tested in accord with Appendix B.

2. No solid fuel burning device permit shall be issued unless said device emits carbon monoxide (CO) at a rate of two hundred (200) grams per hour or less, when tested in accordance with Appendix A or Appendix B, whichever is more stringent.

3. In the event the state, San Miguel County, or the Commission establishes more stringent emission standards, the most stringent standards shall apply.

4. This standard specifically excludes solid fuel burning devices registered according to the provisions of section 8.12.030 of this Chapter; notwithstanding, however, all solid fuel burning devices shall be subject to the provisions for abatement in section 8.12.050 of this Chapter.

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B. Any solid fuel burning device so certified as being with the standards set forth herein shall be presumed to be operated within the limits of those standards. Additional solid fuel burning devices may be certified by the Department upon the applicant's demonstration through testing that the solid fuel burning device will meet these standards, provided tests on that proposed model are conducted by a testing laboratory accredited by the State of Colorado using a standard method and the results are calculated according to TMC section 8.12.070.A as specified in Air Pollution Control Regulation No. 4.

C. On or before August 1st of each year, beginning with August of 1985, the Department will prepare a list of solid fuel burning devices known to be certified, which list shall be available for inspection of the Department's offices.

8.12.030 Administration

A. Between August 15, 1985 and October 15, 1985, all persons who own real property wherein a solid fuel burning device is maintained, used or operated within the Town shall register such device with the Town Clerk on forms provided at the Town Hall. If the owner does not register such device by October 15, 1985, the lessee, if any, may register such device within ten days after the date in the same manner as set forth in this Chapter. The right to register for a solid fuel burning device permit shall be relinquished if no permit is applied for within the time frame as set forth in this section. There shall be an administration fee of fifty dollars for registration and issuance of a permit. No solid fuel burning device permit shall be issued unless the device is in existence within the structure prior to September 15, 1985, or is planned for a structure in which there is at a minimum a foundation in place prior to September 15, 1985.

B. All registrants shall be issued concurrently with the registration of their solid fuel burning device a solid fuel burning device permit which shall: identify the solid fuel cookstove, fireplace insert, etc.; identify the number of solid fuel burning devices in each individually owned unit; and identify the name(s) and address(es) of the unit owner(s) or lessee(s). The original permit shall be valid for three years or until October 15, 1988. Prior to March 1, 1989, the Department will inspect each premises subject to a permit and validate the permit as to full compliance with all provisions of this Chapter. Upon validation this permit will remain in effect as

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long as Chapter 8.12 of the Telluride Municipal Code is in effect, provided, however, that such permits may be subsequently modified or terminated by the Town Council or its designee.

C. On or before August of 1985, the Department will prepare a list of solid fuel burning devices known to be certified, which list shall be available for inspection at the Department's offices.

8.12.040 General Rules and Regulations

A. Only one solid fuel burning device shall be operated per structure unless specifically exempted within this Chapter.

B. It shall be unlawful for any person to construct, install, maintain, use or operate any solid fuel burning device within the Town in any manner which is not in compliance with the provisions of this Chapter.

C. No solid fuel burning device shall be operated in an existing unit after the date for registration as provided in section 8.12.030 of this Chapter without previously having registered and obtaining a solid fuel burning device permit.

D. No coal shall be burned after October 15, 1985, unless used as a primary heat source as of October 15, 1985. There shall be a presumption of prior use upon the person using a solid fuel burning device to burn coal, submitting an affidavit attesting to this use to the Department on or before October 15, 1985. On or after September 15, 1988, no coal shall be burned by any person within the Town.

E. After the date for registration as provided in section 8.12.030 of this Chapter no building permits shall be issued for a new structure which has plans or other provisions for a solid fuel burning device unless there is:

1. Only one solid fuel burning device, which complies with the particulate emission standard and the carbon monoxide standard set forth in section 8.12.020 of this Chapter; and

2. The solid fuel burning device complies with the manufacturer's installation requirements according to the standards of the Town Building Department; and

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3. The solid fuel burning device does result in a net increase in heating energy, that is, the heat energy gained by the unit or structure must be greater than the heat energy lost by the unit or structure; and

4. A solid fuel burning device permit has been obtained from the Town and the applicant has paid the required permit fee; and

5. In the event the cap on solid fuel burning device permits is lifted by Town Council, the applicant for the permit must pay an impact fee of seventy-five ($75) dollars per gram of particulate emission per hour on that model of solid fuel burning device as determined by the standards defined in section 8.12.020 of this Chapter.

F. After the date for registration as provided in section 8.12.030, only one open fireplace will be allowed in the following establishments: hotel lobby, multiple unit dwelling lobby, bar/saloon, or restaurant. No open fireplaces will be allowed in a new home construction.

G. Residential and commercial owners of existing fireplaces will be required to retrofit their fireplaces with a certified fireplace insert by October 15, 1988, as defined by the requirements of certification by Colorado Air Pollution Regulation No. 4.

H. All combustible material for use in a solid fuel burning device shall be in a dry and burnable condition and safely stored so as not to create a fire hazard.

I. All permits may be displayed so as to be clearly visible from the public right-of-way.

J. Wood cookstoves will be exempt from the requirements of this Chapter providing that those stoves are used as a primary cooking source in the house and are in place on or before August 15, 1985. This exemption extends only for the lifetime of the wood cookstove owner and is, therefore, not transferable.

8.12.050 Abatement

A. After October 15, 1988, no person within the Town of Telluride shall operate, construct, use or install a solid fuel burning device unless he or she has obtained a permit from the Town and the solid fuel burning device complies as follows:

1. With the particulate emission standard and carbon monoxide emission standard set forth in section 8.12.020 of this Chapter; and

2. There is not more than one solid fuel burning device per unit or structure; and

3. A permit has been issued by the Town for the solid fuel burning device.

B. A rebate program is hereby established for solid fuel burning device replacements as required within this Chapter: a rebate of $200 for devices replaced from September 15, 1985 to October 15, 1986; a rebate of $150 for devices replaced from October 15, 1986 - October 15, 1987, and a rebate of $100 for devices replaced from October 15, 1987 to October 15, 1988. A full rebate of $250 will be given for total conversion to gas, propane or electric at any time during the October 15, 1985 to October 15, 1988 compliance period. This full rebate is available only to residents who replace the existing permitted solid fuel burning device(s) with a non-solid fuel heat source. The permit for the extinct solid fuel burning device(s) shall then be validated by the Building Department so that it may be sold or used toward the two (2) permits required for installation of one (1) solid fuel burning device in the future, in accordance with section 8.12.030.C of the Telluride Municipal Code.

8.12.060 Number of Permits

A. The Town Council shall allow no additional solid fuel burning device permits for new construction to be issued after the date for registration as provided in section 8.12.030 within the town. Upon the completion of modeling studies to be conducted by the Commission in a written report to be filed with the Town Council on or before October 1, 1986, issuance of additional permits may be considered by the Town Council.

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B. It will be possible for a person wishing to install a new solid fuel burning device in a structure to purchase two relinquished permits, if any are available, in order to install one new solid fuel burning device. In this event, the purchaser must present to the Town Hall proof of purchase of two permits and verification of two deed restrictions, stating that no solid fuel burning device may be used in that unit or structure as long as this Chapter is in effect, in order to install the new solid fuel burning device in a structure. Conformance to all of the provisions of this Chapter will also apply.

8.12.070 Investigation and Noncompliance

A. The Building Department shall inspect each solid fuel burning device as reflected by the records of the Department. The purpose of the inspection shall be to determine that the permitholder is in compliance with the provisions of this Chapter. If a permitholder or person operating the solid fuel burning device refuses to consent to the Department's inspection, the Department may upon a showing of reasonable grounds for the purpose of inspecting solid fuel burning devices only, apply for an inspection warrant from the Municipal Court and execute and conduct the inspection under order of the Court.

B. When the Department has reasonable grounds based upon its investigation or upon written complaints sufficiently demonstrating reasonable grounds that a person has violated this Chapter, the Department shall issue a notice and order setting forth alleged violations and the corrective actions that need to be taken. The Department shall allow thirty days for the person to take the necessary corrective actions and comply with this Chapter.

C. When a person has not complied with the Department's notice and order, the Department shall issue an order of noncompliance and institute a summons and complaint on behalf of the Town with the Municipal Court for violation of this Chapter. The Department may also obtain injunctive relief through the Municipal Court in order to enforce this Chapter. Any order of noncompliance shall be stayed in the event an aggrieved person files a notice of appeal with the Board of Adjustment of the Town as set forth in section 8.12.080 of this Chapter.

8.12.080 Appeals to the Board of Adjustment

A. An appeal of the Department's notice and order of noncompliance shall be filed with the Board of Adjustment of the Town in writing no later than thirty days from the date of the Department's notice and order.

B. The Board of Adjustment shall make such rules and regulations as it determines are necessary for the conduct of its hearings under this Chapter, and according to any other applicable ordinances of the Town and/or the law of the state.

C. Upon a timely filing of a notice of appeal to the Board of Adjustment, the Board of Adjustment shall set a hearing date to review the notice and order of the Department. This hearing date shall be on a date certain not to be less than five (5)days, nor more than fifteen (15) days from the filing of the date of the notice of appeal. The Board of Adjustment shall have the power to subpoena witnesses and a record shall be kept of the hearing. The Board of Adjustment shall issue its decision and order upon the appeal within ten days of the date of the hearing.

D. The Board of Adjustment may affirm, modify, rescind or delay the compliance order based upon the following standards:

1. Planned termination of operations of the noncompliance solid fuel burning device;

2. Planned replacement of the noncomplying solid fuel burning device with a certified device;

3. A change in the operations of the solid fuel burning device due to excusable malfunction;

4. Extreme hardships, or life threatening emergencies.

E. The Department shall represent the Town before the Board of Adjustment and shall have the burden of proof to establish noncompliance by the preponderence of the evidence.

F. The order of the Board of Adjustment shall take effect immediately, and shall contain written findings. The Board of Adjustment may grant a greater time, at its discretion.

G. All appeals from the Board of Adjustment shall be to the court as provided in Chapter 18.36 of the Land Use Code.

8.12.090 Penalties

Any person, upon conviction of a violation of any provision of this Chapter, shall be subject to a fine not to exceed three hundred dollars or imprisonment in jail for a period of not more than ninety days, or both, at the discretion of the court, for each separate offense, and may be enjoined from any further or continued violation of this Chapter. Each day any violation of this Chapter shall continue shall constitute a separate offense under this Chapter.

8.12.100 Colorado Department of Health

The inspector is directed to forward this Chapter to the Division of Administration of the Colorado Department of Health for inclusion in the comprehensive state implementation plan, pursuant to C.R.S. 25-7-128(1), as amended; for administration of the local regulations as part of the state plan, pursuant to C.R.S. 25-7-111, as amended; and for enforcement of the local regulations as part of the state plan, pursuant to C.R.S. 25-76-115, as amended.

EDITOR'S NOTE: This Chapter 8.12 is a codification of Ord. 677, effective August 15, 1985. Ord. 677 was amended by Ord. 682, series 1985; by Ord. 756, series 1986; and by Ord. Nos. 764 and 797, series 1987. Chapter 8.12 was recodified by Ord. 822, series 1988 and was amended to delete a clerical error by Ord.___ series 1988.

Appendix C

Item 5

CRESTED BUTTE, COLORADO

Note: 2 pages excerpts illustrates woodheater installation requirements.

Section 6-5-7. - Installation Requirements and Standards. The following standards and requirements shall apply to the installation of any solid fuel burning device within the Town:

A. Hearth Construction and Clearances.

1. There shall be a minimum of two inches clearance between the hearth and the bottom of the fire box, unless the hearth and clearance of less than two inches is installed as suggested by the manufacturer of the specific solid fuel burning device.

2. When clearance between the hearth and fire box is between two and six inches, the following hearth construction is required:

a. three and one-half inch grouted hollow brick masonry units on edge, or

b. two inches of grouted masonry with 24 gauge sheet metal between such masonry and the fire box, or

c. totally non-combustible construction under the hearth including floor joists, or

d. raise the unit to the point where the fire box is six inches above a two inch grouted masonry hearth with a support system acceptable to the Town, or

e. a U.L. listed "non-combustible floor protector", or

f. such hearth construction and clearance as are suggested by the manufacturer of the specific solid fuel burning device.

3. When the clearance between the hearth and fire box is six inches or more, the following hearth construction is required:

a. a two inch grouted masonry hearth, or

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b. any hearth described above for the two inch to six inch clearance, or

c. such hearth construction and clearance as are suggested by the manufacturer of the specific solid fuel burning device.

B. Stovepipes and/or chimneys shall be installed a required by the National Fire Protection Association's National Fire Code, 1988 Edition, Section 211, which standards are applicable through the Uniform Fire Code as adopted by the Town.

C. The fire box clearance from combustibles in any direction shall be as recommended by the manufacturer of the specific solid fuel burning device. In the absence of such recommendations being approved by the owner of the solid fuel burning device, the clearance shall be as provided by the National Fire Protection Association's National Fire Code, 1988 Edition, Section 211, which standards are applicable through the Uniform Fire Code as adopted by the Town.

D. Any solid fuel burning device installed upon or within any new construction shall have a piped combustion air source originating outside of the structure.

Section 6-5-8. - Application of License Fees. The license fees collected pursuant to Section 6-5-4 of this Article shall be applied as follows:

A. air pollution reduction programs,

B. hiring and/or paying of personnel to enforce air pollution ordinances and regulations,

C. the improvement or replacement of solid fuel burning devices maintained by the Town or other public entities, or

D. any other purpose of the Town Council determines will improve air quality within the Town.

APPENDIX D

EPA FACT SHEET ON HEALTH EFFECTS FROM RWC EMISSIONS

POTENTIAL HEALTH EFFECTS ASSOCIATED WITH WOODSMOKE

NATURE OF THE EXPOSURE

- Wood heaters emit several air pollutants, including particulate matter, carbon monoxide, hydrocarbons, and polycyclic organic matter (POM). Particulate matter dominates these emissions.

- "Woodsmoke" consists almost entirely of small, respirable particles (<10 micrometers (um)), 80% are less than 2.5 um. Thus, woodsmoke can affect all areas of the respiratory tract and readily reach the deep lung (alveolar region). Retention of particles in the deep lung can be quite long, with clearance times of months to years.

- The chemical composition of woodsmoke is diverse and contains a number of toxic, irritant, and carcinogenic compounds.

- In some areas respirable particles from woodsmoke can easily exceed all other forms of ambient air pollution, and on occasion, health-based ambient air quality standards have been exceeded several fold. In addition, residential wood combustion can be a major source of POM emissions, a class of compounds containing carcinogens.

- Woodsmoke generally accumulates near where it is emitted, directly impacting area residents.

HEALTH EFFECTS

Overview

- Health concerns of woodsmoke are associated both with short-term and long-term exposures, particularly where air pollution standards for particulate matter are exceeded.

- Studies examining the effects of particulate air pollution on human populations (epidemiological studies) provide the bulk of the health effects information relevant to woodsmoke. Based on characteristics of particle size and chemical composition, there is no reason to believe that woodsmoke is less toxic or damaging than the general particulate matter measures obtained in these studies; in some instances woodsmoke may be of greater concern and the available health evidence summarized below may not fully characterize health risks associated with woodsmoke.

- Healthy adults may not notice outward effects at high levels other than simple eye, nose, or throat irritation.

- The major groups that should be concerned about more serious respiratory and other responses are people with existing respiratory and cardiovascular disease (for example, asthma, bronchitis, heart disease), the elderly and children. These individuals may experience a variety of overt symptoms such as cough, wheeze, shortness of breath, and chest pain, with increased difficulty associated with everyday activities involving physical exertion. At times symptoms may not be noticeable until several days after pollution episodes.

* Children may be at risk as they breathe woodsmoke deep into their lungs for extended periods while exercising at play.

* Studies have established that exposure to POM-containing mixtures is associated with an excess incidence of lung cancer in humans. Exposure to POM in woodsmoke may therefore pose some cancer risk.

Short-term Exposures

* Clear evidence from epidemiological studies implicates particulate pollution in aggravating disease among bronchitics, asthmatics, cardiovascular patients, and people with influenza (U.S. Environmental Protection Agency, 1982, 1986).

* Specifically, particulate matter pollution may:
  - Increase mucus loading or otherwise affect the airways of bronchitics, aggravating their debility.
  - Cause bronchoconstriction (a common response to respiratory irritants) in a variety of individuals (e.g., asthmatics, bronchitics) or even asthma "attacks" in some instances. Associated depression in lung function may be incapacitating or even life threatening for severely ill or sensitive patients.
  - Affect oxygen uptake in the alveolar region; this is particularly important for patients with severely compromised lung capacity (e.g., emphysema).

* Laboratory studies indicate that mucociliary clearance (the ability of the respiratory tract to clear foreign particles, bacteria, etc.) or other lung defense mechanisms may be altered. Several community epidemiological studies suggest increased respiratory infection during pollution episodes.

* Particulate pollution episodes are associated with reduced lung function in children, these changes may persist for up to two weeks after the exposure (Dockery et al., 1982).

* Studies conducted in areas with high particulate pollution, comparable to levels occasionally reported in areas heavily impacted by woodsmoke (i.e., 4-5 times the ambient standard), report increases in mortality in the elderly and other sensitive populations (see U.S. Environmental Protection Agency, 1982, 1986).

Long-term Exposures

* The effects of chronic exposure to air pollution can be quite difficult to discern without fairly involved epidemiologic techniques. For particulate pollution, a number of community epidemiological studies indicate higher prevalance of respiratory symptoms such as wheeze and cough, increased respiratory illness and disease, or lower lung

function for populations living in areas of high pollution. In particular, children in such areas may show increasd rates of illness (e.g., Ware et al., 1986), which might have longer-term consequences.

- Long-term exposure to particles has produced lung tissue damage in laboratory animals.

- The presence of carcinogenic compounds in woodsmoke, and potential interaction with other pollutants and cigarette smoke, raises some concern about possible lung cancer in exposed populations.

REFERENCES

Dockery, D. W., et al. (1982) Changes in pulmonary function associated with air pollution episodes. J. Air Pollut. Control Assoc. 32: 937-942.

U. S. Environmental Protection Agency. (1982) Air quality criteria for particulate matter and sulfur oxides. Research Triangle Park, NC: Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office; EPA report nos. EPA-600/8-82-029-cF. 3v.

U. S. Environmental Protection Agency. (1986) Second addendum to air quality criteria for particulate matter and sulfur oxides (1982): assessment of newly available health effects information. Research Triangle Park, NC: Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office; EPA report no. EPA 600/8-86/020F.

Ware, J.H., et al. (1986) Effects of ambient sulfur oxides and suspended particles on respiratory health of preadolescent children. Am Rev. Respir. Dis. 133:834-842.

APPENDIX E

HOW TO APPLY ESTIMATES OF EFFECTIVENESS TO DETERMINE TOTAL PM-10 SIP EMISSION REDUCTION CREDITS

In preparing the SIPs to address PM-10 nonattainment, it is necessary to estimate how effective a given RWC emission control program will be in reducing ambient levels of PM-10. These estimates are referred to as "credits." The credits are applied to the highest ambient levels that have been experienced or are forecasted to occur (i.e., the design day or design year conditions).

The purpose of this section is to explain this general process and to illustrate specifically how credits from various program elements can be combined to demonstrate attainment. For the hypothetical example, only the 24-hour standard -- which is sole cause of PM-10 NAAQS violation among existing areas with serious RWC emissions problems -- is addressed. A similar approach must also be used to address the annual standard.

1.0 GENERAL APPROACH TO DEMONSTRATING ATTAINMENT

In general the process of demonstrating attainment with the PM-10 NAAQS includes the following six steps:

Step 1 -- Based on monitoring and modeling results determine the worst case or design day ambient concentrations and the improvement in ambient quality needed to attain the NAAQS.

Step 2 -- Based on modeling or other source apportionment techniques determine the proportion of PM-10 concentrations attributable to RWC compared to PM-10 from all sources, as measured during the design day.

Step 3 -- Based on the overall PM-10 emission inventory for all source categories -- such as RWC, road sanding, diesel exhaust, industrial emissions, etc. -- determine overall emission reductions needed to attain the NAAQS. This is accomplished by multiplying the percentage reduction needed (from Step 2) by the total PM-10 emitted during the design day (or design year, if the annual standard is violated).

Step 4 -- Based on the contribution of various source categories and the costs, effectiveness, and acceptability of controlling these sources, decide which source categories should be controlled and which control programs will be deployed in order to demonstrate attainment with the PM-10 NAAQS. Not all source categories will be able to make the same percentage reductions in emissions because of technical and economic difficulties. Therefore, policy decisions on the degree of reduction from each control program will be necessary.

Step 5 -- Based on the total estimate of PM-10 from RWC (from the inventory in Step 3 and discussed in Appendix A of this report) and on the policy decisions regarding the degree of emission reduction required from each source category, it is possible to calculate the quantity of PM-10 reductions needed from RWC. This becomes the emission reduction target.

Step 6 -- Select from among the various program elements in Section 3 through 5 of this report in order to find one element or a combination that can accomplish the net emission reduction calculated in Step 5.

Typically there will be several iterations between steps 4-6 in order to select the most cost-effective and most acceptable measures.

The example in Section 2 below is a hypothetical illustration of all six steps. Section 3 and 4 provide details that illustrate the application of the credits and how to calculate the accumulative credits.

2.0 EXAMPLE -- SMALL TOWN WITH MODERATE PM-10 EXCEEDANCES

A town of 3,000 population set in a high mountain valley is determined to be in violation of the 24-hour PM-10 NAAQS of 150 $\mu g/m^3$.

Step 1 -- Atmospheric monitoring results along with supplemental or confirmatory modeling analyses show that last winter there were a dozen days in which the PM-10 NAAQS was exceeded. The worst of these was a 300 $\mu g/m^3$ episode. This is the design day. The area SIP is required to show a 150 $\mu g/m^3$ reduction in PM-10 ambient concentrations to demonstrate attainment with the NAAQS.

Step 2 -- Based on modeling studies, it was determined that two-thirds of all PM-10 concentrations on the design day are from RWC. In other words, when the ambient PM-10 concentrations were at 300 $\mu g/m^3$, two thirds or 200 $\mu g/m^3$ of PM-10 are attributable to RWC.

Step 3 -- The town staff prepares an emission inventory of all PM-10 sources and of RWC emissions based on a survey and emission estimating techniques presented in Appendix A. PM-10 emissions on the design day are 465 Kg with RWC sources accounting for 310 Kg.

Step 4 -- The town council examines various alternatives for reducing PM-10 emissions on the design day. They decide that paving the few unpaved streets and their relying on RWC controls is the most cost effective and least disruptive strategy for attaining the PM-10 NAAQS.

Step 5 -- Having decided that they can get about 65 percent of the ambient improvement needed from street paving, the council must come up with the remaining 35 percent from RWC emissions reduction. Because emissions reduction and ambient concentration reduction is assumed to be linear, the cutback in RWC emissions is calculated to be 65 percent.

The 65 percent emission reduction must be applied to the baseline inventory of RWC sources. (Appendix A of this report provides suggestions and further references for developing such as inventory.) Following are some of the base line inventory data for the design day extracted from the hypothetical RWC inventory developed by the town staff (noted in Step 3).

- 600 conventional woodstoves emit: 200 kg/day (or 0.33 kg per unit);
- 200 certified stoves (1/3 of which are EPA Phase II) emit: 40 kg/day (or 0.2 kg per unit);
- 100 fireplaces emit: 70 kg/day (or 0.7 kg per unit) based on very limited number of hours that fireplaces are believed to be operated;
- Total: 310 kg/day all RWC sources (200 plus 40 plus 70).

If the total RWC emissions on the design day are 310 kg and if a 65 percent emission reduction is needed from RWC to demonstrate attainment with the 24-hour PM-10 NAAQS, the amount of emission reduction from RWC sources is 310 kg X 0.65 = 202 kg. This 202 kg is the PM-10 emission reduction target for RWC.

Step 6 -- Out of concern over health issues and the deteriorating visibility over much of the winter, the town council decides to implement a variety of measures that will address both the persistent and episodic woodsmoke problem. The measures the council selected were from among those presented in this report and summarized in Appendix F. The council hopes measures they have selected will achieve the 202 kg reduction needed to demonstrate attainment with the 24-hour standard for PM-10. The hypothetical measures are described below in Section 3.0 along with the emission credits EPA agreed to award for each. The actual calculation of these credits is provided in Section 4.0.

3.0 DESCRIPTION OF MEASURES AND CREDITS IN HYPOTHETICAL EXAMPLE

Registration and Permit System

In order to establish control over the growth of new RWC population and the existing RWC population, the council decides to require all existing RWC devices to be registered and issued a permit within 30 days. To pay for the administration of the program and to fund a public awareness/education program, the council establishes a permit fee of $30. The council also votes to make it a crime (misdemeanor) to operate an RWC device without a permit. Finally, the council also requests that the staff, working with the EPA Region and State officials, develop a public awareness program.

Public Awareness/Education

The city staff decides to have a two-phase public awareness/education effort. The first phase, which occurs during the 30-day registration period, focuses on persuading the public that there is a problem and informing them of the various approaches available for resolving the problem. The second phase, which will begin with the adoption of the control measures, will continue the persuasion effort, provide education material on RWC appliance selection and operation, and provide specific information on the reason for and means of complying with the control measures.

During Phase I, the council holds two public hearings (town hall type meetings). The first focuses on the extent and causes of the woodsmoke problem, the effects of woodsmoke on health and the local tourist industry, and a description of the various approaches. EPA and State experts make presentations and field questions from the public. On the day before the hearing, the experts make presentations at the local school and at two civic groups. The local newspaper agrees to run a series of articles on these topics before the second hearing, which focuses on a discussion of control measures.

Although no emission reduction credits are given to the town by EPA for this public awareness effort, the EPA regional staff are optimistic about the eventual success of the overall program (i.e., package of control measures or program elements) because of the increased likelihood of public support generated by the public awareness program element.

Alternative Fuels Initiative

During the public hearings, the local LPG (liquid petroleum gas--butane/propane) distributor offers to pay the LPG installation costs for the first 200 owners of existing uncertified RWC devices who switch from wood to LPG for residential heating if the town will pay each RWC device owner $100 for the voluntary surrender of his permit. The town council agrees to do this. The EPA estimates that this will result in the removal of 25 fireplaces and 175 conventional stoves during the first year of the program. The EPA will grant a 100 percent emission credit for each unit involved in this effort.

RWC Inspection Program

The town council decides to require that the permits be renewed each year. The conditions of renewal are a $10 registration fee and a certification that the RWC device (including the flue and chimney apparatus) and the dwelling have been inspected by an industry-accredited and town council-approved inspector. The EPA agrees to apply a 5 percent emission credit for the RWC appliance inspection element. The credit will be applied to the emissions remaining after the application of the alternative fuels initiative.

Wood Moisture

The inspector certification described above also includes a requirement that each RWC device owner demonstrate that he has a covered wood shed and use only wood that has been seasoned for nine months. Inspectors are encouraged to use moisture meters or make visual observations to confirm that these conditions are being met. The EPA agrees to allow another 5 percent emission credit after application of the two previous measures.

Weatherization

As a final criteria for inspector approval (and therefore permit renewal), the residence (which contains the permitted RWC device) must meet minimum insulation and caulking requirements to minimize heat loss. The EPA agrees to add another 5 percent for this program element. This credit is to be given after calculation of the foregoing elements.

Opacity Limits

The town council agrees to have the city police officer who will enforce the curtailment program to be trained as a smoke reader in order to ensure that opacity from chimneys do not exceed 20 percent. The opacity ordinance would be enforced during the periods when a curtailment is not in effect (any opacity during this period would indicate noncompliance). The EPA agrees to recognize another 5 percent for this program element--to be subtracted after calculation of the foregoing elements.

Mandatory Curtailment

As a final measure the town council agrees to adopt an ordinance curtailment program. During a curtailment, all fireplaces and stoves that are not EPA certified (Phase II) would be required to cease burning under penalty of a $50 fine (going to $100 after the first offense). The EPA agreed to award 50 percent emission credits for each woodstove and 60 percent emission credits for each fireplace for each RWC device affected by the curtailment order (i.e., after application of all the preceding "permanent" measures).

4.0 MATHEMATICAL CALCULATION OF CREDITS AS APPLIED TO THE HYPOTHETICAL EXAMPLE

1) From the discussion above, 310 kg is the design day RWC emissions estimate based upon:

600 conventional stoves	200 kg	0.33 kg per stove
200 certified stoves (one third Phase II certificate)	40 kg	0.20 kg per stove
100 fireplaces	70 kg	0.70 kg per fireplace
	310 kg	

2) The emission reduction target is 310 kg times 0.65 equals 202 kg where 0.65 is the amount of reduction need in PM-10 emissions.

3) The alternative fuels initiative results in the following change:

25 fireplaces x .7 kg/fireplace + 175 stoves X .33 kg/stove = 17.5 kg plus 58.3 kg = 76 kg emissions removed.

4) New emission inventory after alternative fuels initiative is:

425 conventional stoves (600-175)	142 kg	0.33 kg per stove

200 certified stoves (one third Phase II certificate)	40 kg	0.20 kg per stove
75 fireplaces (100-25)	53 kg	0.70 kg per fireplace
	235 kg	

5) Each of the next four emission reduction measures results in a 5 percent reduction of emissions from the inventory. These are additive (declining balance).

235 kg x .95 x .95 x .95 x .95 = 191 kg

The cumulative emissions reduction at this point is 310 kg (the baseline inventory) minus 191 kg (the inventory after application of alternative fuel initiative plus RWC inspection, wood moisture, weatherization, and opacity limits). The resulting value is 119 kg (310-191 = 119). The 119 kg in "permanent" reductions still falls short of the 202 kg needed for design day episodes. Therefore, curtailment is added.

6) Curtailment effects all but one-third of the certified stoves (because an estimated one-third of these stoves are Phase II certified stoves). Therefore the number of RWC devices affected by curtailment, is:

425 conventional stoves x 50% = 212 x (0.33 kg) x $(.95)^4$ = 57 kg
133 certified stoves (2/3 of 200) x 50% = 66 x (0.20 kg) x $(.95)^4$ = 11 kg
75 fireplaces x 60% = 45 x (0.70 kg) x $(.95)^4$ = 26 kg

The total emissions reduction from curtailment is 57 kg (conventional stoves) plus 11 kg (certified stoves) plus 26 kg (fireplaces) equals 94 kg.

7) When the 94 is added to the 119 (from 5 above) the total emission reduction is 213 kg. The 213 exceeds the emission reduction target and, therefore, the town has demonstrated that its RWC emission control program is sufficient to bring it into PM-10 attainment within one year.

In summary, the town council (in this hypothetical example) has implemented a RWC emissions control program which results in an estimated reduction of about two thirds over the RWC baseline emissions. The combination of measures results in both permanent cutbacks and temporary reductions and is achievable within one year.

APPENDIX F

SUMMARY TABLE OF PROGRAM ELEMENTS[1]

	Program Elements	Effectiveness (%)	RWC Devices Affected	Emissions Affected	Timing	Combination
1.	IMPROVEMENT OF PERFORMANCE					
a.	State implementation of NSPS	0	State's are not expected to adopt this program element at levels that would affect program effectiveness significantly.	N/A	N/A	N/A
b.	Ban on resale of uncertified devices	0	No credit recognized because requirement is largely unenforceable; other elements will be required to include disabling of retired used devices.	N/A	N/A	N/A
c.	Installer Training Certification or Inspection Program	≤5	Reduction in emissions from each new certified RWC device where either the installer is trained/certified or the installation is inspected.	New Emissions	Phased in	Combines well with other measures.
d.	Pellet stoves	90	Reduction in emissions from each new or existing conventional, uncertified RWC device replaced with a pellet stove.	New and existing emissions	Immediate	Pellet and low emitting stove requirements are mutually exclusive.
		75	Reduction in emissions from each new or existing Phase II EPA certified RWC device replaced with a pellet stove.	New and existing emissions	Immediate	
e.	EPA Phase II certified RWC devices	Approximately 50[2]	Reduction in emissions from each new or existing conventional, uncertified RWC device replaced with an EPA Phase II certified RWC device.	Existing emissions	Immediate	
f.	Retrofit requirement	<5	Reduction in emissions from each existing conventional, uncertified RWC device equipped with a retrofit catalyst or pellet hopper (to maximum when all existing uncertified RWC devices have retrofit devices installed).	Existing emissions	Immediate	Could be combined with technology requirements for new residences to reduce remaining emissions.

(Continued)

APPENDIX F (continued)

	Program Elements	Effectiveness (%)	RWC Devices Affected	Emissions Affected	Timing	Combination
g.	Accelerated changeover requirement	Approximately 50^2	Reduction in emissions from each existing conventional, uncertified RWC device replaced with Phase II certified device.	Existing emissions	Phased-in	Would be mutually exclusive with technology requirements.
		100	Reduction in emissions from each existing conventional, uncertified RWC device removed and not replaced; requires existing device to be disabled and not resold.	Existing emissions	Phased-in	Would be mutually exclusive with technology requirements.
h.	Accelerated changeover inducement	Approximately 50^2	Reduction in emissions from each existing conventional, uncertified RWC device replaced with Phase II certified device.	Existing emissions	Phased-in	Would be mutually exclusive with technology requirements.
		100	Reduction in emissions from each existing conventional, uncertified RWC device removed and not replaced; requires existing device to be disabled and not resold.	Existing emissions	Phased-in	Would be mutually exclusive with technology requirements.
i.	Require fireplace inserts	0	No credit recognized for fireplace inserts, since inserts change use of fireplace from aesthetic to primary heat source, resulting in increase in amount of wood combusted and higher overall emissions.	N/A	N/A	
j.	Wood moisture	<5	Reduction in total emissions from all RWC devices in the community/ airshed.	New and existing emissions	Immediate	Would reduce remaining emissions after application of other measures.
k.	Trash burning prohibition	0	No credit recognized for eliminating trash burning in RWC devices.	N/A	N/A	
l.	Weatherization of residences	<5	Reduction in total emissions from all RWC devices in the community/ airshed.	New or existing emissions	Phased-in	Would reduce remaining emissions after application of other measures.
m.	Opacity limits	<5	Reduction in total emissions from all RWC devices in the community/ airshed.	New or existing emissions	Immediate	

(Continued)

APPENDIX F (continued)

	Program Elements	Effectiveness (%)	RWC Devices Affected	Emissions Affected	Timing	Combination
2.	REDUCING USE OF RWC DEVICES					
a.	Availability of alternative fuels	100	Reduction in emissions from each RWC device removed from service and replaced with device using natural gas; recognize no more than 10 percent of RWC devices replaced under program with no additional incentives.	Existing emissions	Phased-in	Could be combined with certification or technology requirements to increase adoption of alternative fuels.
b.	Emission trading	Computation Required	For a 2:1 trading ratio, the reduction in emissions from each new stove would be calculated as the difference between emissions of a new RWC device and 2 times the average emissions per stove in the community; multiplier would change for other trading ratios.	New and existing emissions	Phased-in	
c.	Taxes on RWC devices	Variable	Emission reduction credit would vary with utility or tax rate structure adopted and extent to which this structure resulted in reduction in number of RWC devices in the community versus reduction in use of RWC devices.	New and existing emissions	Phased-in	Would be most effective in combination with an active PA campaign.
d.	Regulatory ban on RWC devices in new dwellings	100	Reduction in emissions from new RWC devices purchased for installation in new dwellings.	New emissions	Phased-in	Bans on RWC devices in some residences could be combined with technology requirements on remaining residences to enhance effectiveness.
e.	Regulatory ban on existing RWC devices	100	Reduction in emissions from each RWC device removed.	Existing emissions	Immediate	Mutually exclusive with other elements.

(Continued)

APPENDIX F (continued)

	Program Elements	Effectiveness (%)	RWC Devices Affected	Emissions Affected	Timing	Combination
3.	CURTAILMENT					
a.	Voluntary (assumes recommended features in Table 5-8)	10	Reduction in emissions for all RWC devices not exempted.	New and existing (temporary effect)	Immediate	Combines well with other measures.
b.	Mandatory (assumes recommended features in Table 5-9)	60% fireplaces 50% woodstoves	Reduction in emissions for all RWC devices not exempted	New and existing (temporary effect)	Immediate	Combines well with other measures.

[1] Note: See discussion on credit derivation in Section 1.4.1 and specific discussions for each element before using these values.

[2] Effectiveness depends on replacement device. See Appendix to obtain emission factors, wood burn rate adjustments (e.g., EPA Phase II stoves are more efficient than conventional stoves) and performance degradation discussion (i.e., the SIP must provide for deterioration in performance). The numbers are nominal values appropriate for first cut estimates. They assume a mix of appliances, degradation of performance of catalytic stoves, and that NSPS stoves burn wood more efficiently than do conventional stoves.

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(Please read Instructions on the reverse before completing)

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16. ABSTRACT

This publication was prepared to provide guidance to State and local air pollution control agencies with regard to emission control measures for residential wood combustion (RWC). The guidance is specifically directed to agencies that are required by the U.S. EPA to demonstrate through the State implementation planning process that the national ambient air quality standard for PM-10 will be attained. There are four categories of RWC emission control measures: public awareness, combustion efficiency, restriction or reduction in the number of RWC devices, episodic curtailment. A hierarchy of effectiveness and reliability of emission control measures is presented. Methods for developing estimates of RWC emissions are presented in order to apply a quantitative estimate of effectiveness of control measures.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Residential Wood Combustion PM-10 Emissions Curtailment Public Awareness Control Measures Effectiveness		

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